WHAT TO EAT

IN HEALTH AND DISEASE

WHAT TO EAT

IN HEALTH AND DISEASE

BY

BENJAMIN HARROW, PH.D.

ASSOCIATE IN PHYSIOLOGICAL CHEMISTRY, COLLEGE OF PHYSICIANS AND SURGEONS, COLUMBIA UNIVERSITY

Author of "Vitamines," "Glands in Health and Disease," Etc.

NEW YORK

E. P. DUTTON & COMPANY

681 FIFTH AVENUE

Printed in the United States of America

PREFACE

This book is intended as a guide for those who want to know what to eat and *why*. The more important facts which have become established and theories which have been advanced during the last few years are included. The book is a non-technical but, I trust, strictly scientific account of our knowledge of foods.

The chemistry, physiology and anatomy of the digestive tube are discussed in the last chapter. Some readers may want to begin the book by reading this chapter first. This would be an excellent plan for those whose knowledge of biology is still in its early stages.

On the other hand, those readers who are in a particular hurry to apply the facts may start with Chapter 3, The Planning of Meals.

I am indebted to the following: Professor Emil Abderhalden (Halle); Professor R. H. Chittenden (Yale); Dr. Casimir Funk (Columbia); Professor W. J. Gies (Columbia); Mrs. Carolyn S. Harrow; Dr. M. Hindhede (Copenhagen); Professor F. G. Hopkins (Cambridge); Dr. Max Kahn (Columbia); Professor E. V. McCollum (Johns Hopkins); Professor L. B. Mendel (Yale); Dr. T. B. Osborne

(Connecticut Experimental Station); Mr. A. L. Robert; and Mrs. N. J. Wallerstein.

Mr. Thomas Spector is responsible for the diagrams in the last chapter. These diagrams are based largely on illustrations that may be found in Foster's *Elementary Physiology* (Macmillan), Ritchie's *Human Physiology* (World Book Co.), Davison's *The Human Body* (American Book Co.), and Huxley's *Lessons in Elementary Physiology* (Macmillan).

BENJAMIN HARROW.

CONTENTS

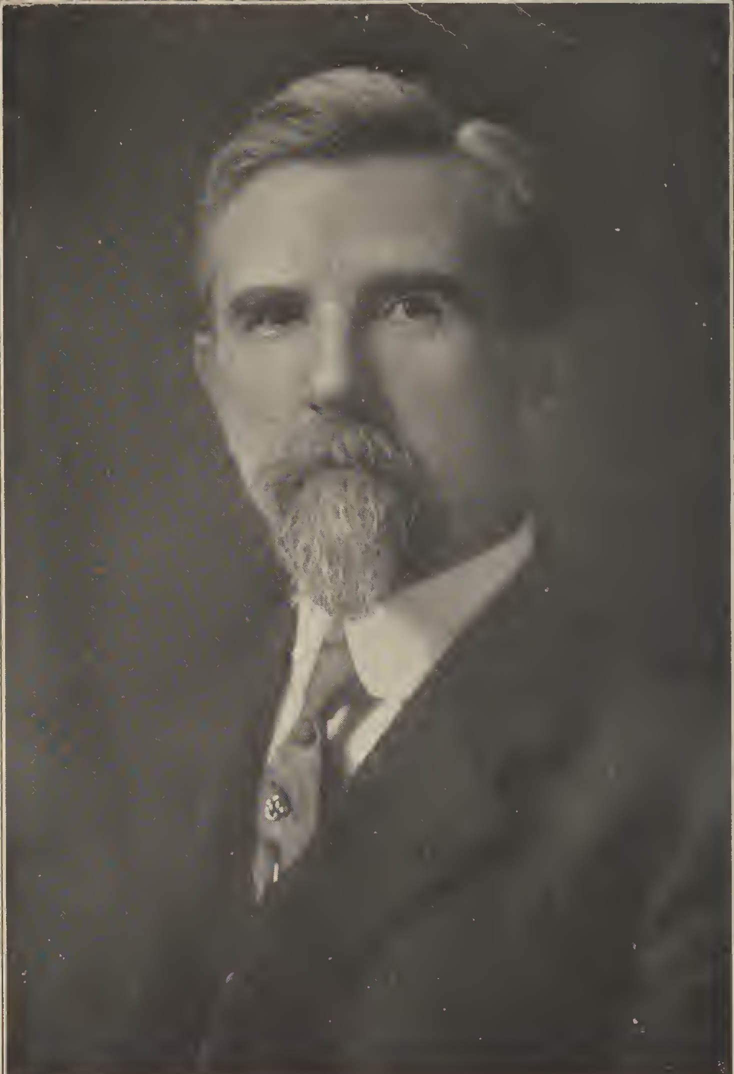
ILLUSTRATIONS

PHOTOGRAPHS

FIGURES IN THE TEXT

WHAT TO EAT

IN HEALTH AND DISEASE



RUSSELL HENRY CHITTENDEN, DIRECTOR OF THE SHEFFIELD SCIENTIFIC SCHOOL, YALE UNIVERSITY. HIS NUTRITIONAL STUDIES ARE COUNTED AMONG THE SCIENTIFIC CLASSICS.

WHAT TO EAT

CHAPTER I

WHAT TO EAT

The question of what to eat involves much knowledge. You must know the composition of the foodstuffs; you have to be familiar with the organs that digest them, and with the chemistry and physiology involved; you have to know the fate of these foodstuffs in the body, and how they affect the different organs of the body. Bitter experience, coupled with a peculiar something which for want of a better name we call "instinct," have been our guides in the past; but since the days of Lavoisier nutrition has been a science, built on principles as sound (or unsound) as any other boasted science.

Lavoisier. Lavoisier showed that substances were "burnt" in the body by absorbing oxygen and giving out carbon dioxide, in much the same way that a piece of wood or coal is burnt. With the help of his scales he introduced quantitative measurements. As the idea of *quantity* underlies all the sciences, we may justly speak of Lavoisier as

the founder of the *science* of nutrition. Incidentally, he was the founder of the modern science of chemistry. But that is another story.

Lavoisier lived in Paris in the days of the French Revolution. He was an aristocrat. He had been Farmer-general and tax-gatherer for the royal government. Marat, "l'ami du peuple," would have none of him. Lavoisier was an aristocrat; that was enough for one execution. But Lavoisier was a bad chemist in addition! "Lavoisier," writes Marat, under the flattering title of "Modern Charlatans," "the putative father of all the discoveries that are noised about, and having no ideas of his own, snatches at those of others; but having no ability to appreciate them, he quickly abandons them and changes his theories as he does his shoes." Bloated aristocrat and poor chemist, away with him! And once again in the history of mankind a Galileo is made to suffer—this time not by an Inquisition and a Religion, but by the People and in the name of Freedom. A wise man of the times remarked, in private, that "it took but an instant to cut off his head; a hundred years will not suffice to produce one like it."

The calorie. From Lavoisier to the calorie is but a stepping-stone. As soon as you introduce the ideas "scale" and "quantity," the question arises as to what unit of measurement is to be adopted. We have a foot for length and a pound

for weight and a second for time; we shall now adopt the *calorie* as the unit of heat. This unit is the amount of heat necessary to raise the temperature of one kilogram (about two and one-fifth pounds) of water one degree (centigrade).

Lavoisier has taught us that foods are "burnt" in the body. This means that, among other things, heat is evolved. Such heat, in turn, can be measured in terms of calories.

The average of thousands of experiments in different parts of the world leads to a figure closely approximating 2700 as the number of calories per day "needed" by man. This is merely another way of saying that the average man "burns" enough food each day to yield 2700 calories, and therefore the body needs to be replenished by that amount.

During the Great War—and to this day in parts of Russia and Austria, China and India, and among the very poor in every country—it was not always easy for man to procure enough food to yield 2700 calories. Some wise ones told him to chew his food longer than was his wont; others suggested certain plant products that make up in bulk what they lack in fuel value (clay in your coal as it were). The results, sometimes encouraging at first, invariably ended in the same way: a lowering of the general resistance of the organism, and therefore a greater susceptibility to disease. Biochemists and bacteriologists, working

with rats and bacteria, might have prophesied some such result. Even bacteria refuse to thrive when undernourished!

Holt, the children's specialist, finds from his experience that a child one year old needs 100 calories for every kilogram of body weight (the kilogram being two and one-fifth pounds), that the needs slowly decrease to 80 calories until the tenth year is reached, and that, after the growth cycle is completed, 44 calories per kilogram suffices. During growth, substitution and addition of tissue are active; after the growth cycle has been reached, there is substitution only.

The "nem." The War has not only dethroned monarchs and broken up monarchies, but it even threatens to destroy our hitherto accepted food unit, the calorie. During the War the Austrian government, guided by the German government, which in turn was guided by Rubner and several other professors *ordinarius* from German universities, did not handle the food situation as wisely as it might have done. The armistice and the blockade but aggravated difficulties. At this point Pirquet, the famous Viennese pediatrist, came to the front. The Hoover Commission had undertaken to feed daily some 300,000 undernourished Austrian children. Pirquet suggested that in feeding these children the calorie as a unit be discarded and the "nem" substituted. The name "nem" is derived from the

initial letters "nutrition," "element" and "milk." The Pirquet unit is one cubic centimeter (one-thousandth of a quart) of milk, which is equal to one "nem." Roughly speaking, the Pirquet system is based on the following factors, sufficiently complex in themselves to make entertaining reading:

1. There is a mathematical relationship between the weight of a person and his sitting height, which may be expressed as ten times the weight, divided by the sitting height cubed, equals one hundred, if the person is in "normal" health; or

$$\frac{10 \times \text{weight}}{(\text{sitting height})^3} = 100.$$

The child is weighed and his sitting height measured; if by the use of the above formula the figure obtained is anywhere from 88 to 94 (instead of 100), then Pirquet assumes that the child is undernourished. An obese child would show a figure above 100; possibly as high as 110. Hardly any child, no matter how thin, would give a figure much below 88.

2. Pirquet's second assumption is that there is a mathematical relationship between the sitting height and the absorptive surface of the alimentary canal, in that the square of the sitting height equals the absorptive surface.

3. His third assumption is that the child needs

one "nem" for every square centimeter of surface. The total number of "nems" needed may therefore be calculated from (2).

If these assumptions are accepted, (1) yields the data as to whether the child is undernourished, and (2) furnishes the data as to how many "nems" the child needs. Pirquet's further assumptions that the protein should form ten per cent of the total diet, that the fat and the carbohydrate are interchangeable (in that you can employ a high carbohydrate and low fat diet, or *vice versa*), and that it is important to include a food containing vitamine *A*, give us the basis for a rational method of testing and feeding. It needs little scientific training to apply the tables provided by Professor Pirquet.

The "nem" system has been used in Vienna with marked success, and even in San Francisco Dr. Carter, a Pirquet disciple, claims to have applied it successfully. He writes: "The experience of Mr. Hoover and Professor Pirquet in Central Europe is ample evidence that the nutritional status of children fed by this method is markedly improved in a surprisingly short time. The sending of food for the relief of the children of Central Europe was highly commendable; in fact, it was one of the most generous things that history records. Yet we should not overlook the fact that many of our own children, judged by the same stand-

ards employed by the American Relief Administration, are in need of supplemental food." What teacher, unfamiliar with the Pirquet system though he be, but familiar with the schoolchildren of this country, could not subscribe to this last sentence?

The composition of food. Carbohydrates, fats, proteins, mineral salts, and water are the common constituents of food. We now have to add vitamines to the number, and we have to consider, rather more carefully than was thought necessary, the composition or chemical make-up of the protein. Though not usually included among foodstuffs, oxygen is in reality a very essential food. Without oxygen there can be no combustion or "burning" of foods in the body, just as without oxygen we can have no fires. With our usual tendency to emphasize the things that *cost* rather than the things that are *essential* (often, we must admit, a difficult separation), neither oxygen nor water receives its proper due. If anything, poor oxygen is neglected even more than water, for the State has devised a water-tax, but our legislators have yet to propose an oxygen-tax. Why scientists should complain because politicians are ignorant of science, I cannot well make out. Since oxygen is an element, and therefore cannot be divided into anything simpler, we need trouble ourselves no further about its composition.

Carbohydrates. These are the primary energy

producers. The sugars (cane sugar, candy, jellies), starch (in grains, bread) and cellulose (in potatoes, fruits and vegetables) are common examples. Various experiments have shown that though the fats and even a part of the protein molecule serve as energy producers, the complete absence of carbohydrate from the diet gives rise to various disturbances. It should also be remembered that the laxative properties of food are largely due to the carbohydrates in them; and man when in normal health needs no other laxative than the food he eats.

Fats. Butter is perhaps the commonest variety of fat. Various oils, lard, portions of meat, and cream, are other examples. It has already been pointed out that fats, like carbohydrates, are energy producers; but the fats act as the reserve forces. The carbohydrates are the active fuel producers and the first in the field; the fats are called upon when the carbohydrate supply is well-nigh exhausted.

It may be asked, if both fats and carbohydrates are fuel producers, why must we have both of them? Why will not one or the other do? We have already indicated that experience has taught us to include carbohydrates in the diet; and we have also indicated, but we ought to emphasize again, that carbohydrates are of value aside from their fuel properties. The intake of fats must also be con-

sidered as a more complicated process than the mere addition of so much fuel. During the War the Germans attributed many of the consequences of undernutrition to lack of fats. Fats in foods invariably include a group of substances known as lipoids, which, from their great abundance in brain tissue and their presence in all cells, bespeak an importance for them. In addition to this, most fats have small quantities of one of the vitamines adhering to them. To what extent the supposed indispensability of fats in the diet is due to the fat, and to what extent it is due to chemical impurities tenaciously adhering to it, is debatable. Drs. Osborne and Mendel, the New Haven physiological chemists, have conducted several experiments with rats receiving diets adequate in every respect except that the amount of pure fat given to them was extremely small (it was found *impossible* to exclude traces of fat from the diet); the rats were kept many months and apparently thrived well. Since traces of fat still remained in the diet, the question whether fats are indispensable still remains to be answered. All that one can say is that if fats are necessary, the amount needed seems to be very small indeed. Such is also the opinion of the Danish investigator, Dr. Hindhede.

The Japanese are notorious among races that include very little fat in their dietary; and unless we stretch our imagination to assume that their

stature may have suffered because of some possible connection between it and fat metabolism, they show no lack of health.

There is, however, another side to the story that dietitians and social workers must not lose sight of, and that is the question of taste. Much of the food we Occidentals eat has the peculiar flavor we relish because of a liberal use of fats. Without them, food becomes monotonous, unrelished, unpalatable; glandular factories remain idle; enzymes are but slowly activated; the flow of digestive juice is delayed; and "digestive upsets" may result.[1]

Protein. We cannot do without protein (of which large percentages of meat, fish, milk, and eggs, and smaller percentages of cereals and vegetables, are examples): so much is certain. To put it in a very elementary way, protein is the only one among our foodstuffs that contains nitrogen, and our tissues need nitrogen—not, unfortunately for our pocketbooks, in the free state such as we find it in the air, but in the combined and more expensive form of protein (or its decomposition products, the amino-acids).

Having decided what our total calorific needs are (probably in the neighborhood of 2800 calories), we must next decide how to apportion our food-

[1] Holt is of the opinion that fat has an important influence on mineral metabolism, and that it increases the body's resistance to disease; but these views have little experimental evidence to support them.

stuffs; how much protein, and how much fat and carbohydrate are we to take? Lusk and Pirquet advise the use of ten per cent of our total food in the form of protein; the rest may be distributed among the fat and carbohydrate, with a decided preponderance in favor of the latter (perhaps one part of fat to ten parts of carbohydrate). But opinions differ very widely, and low and high protein faddists flourish in all quarters of the globe. We shall say a word or two in favor of both sides, and then, like Sir Roger de Coverley, draw the conclusion that a happy medium is perhaps the best line for us to follow at present.

Early advocates of a high protein diet were guided by the experience of mankind. Man was a flesh eater; he liked it well, and he apparently thrived; therefore flesh he shall have. Some pointed out that this reasoning had elements of fallacy in it. Man's early ancestors were not flesh eaters, was the claim, and they were unquestionably much stronger physically than is present-day man. Others pointed out that many of man's ailments are due to an abundance of meat in the diet. Still others hinted that the trouble was not with the *amount,* but with the *kind* of protein eaten. But man went —and still goes—much his own way, letting scientists dispute, eating meat if he had the money, and only going without it if he had not. Some statistics at this point are valuable to illustrate the di-

rect proportion that exists between the amount of meat consumed and the state of prosperity of a country. Before the War the consumption *per capita* per year (in pounds) was: England, 105; Belgium and Holland, 75; France, 74; Austria-Hungary, 65; Italy, 23. If a study of any one country is made, we find an increased consumption of meat with succeeding years. In Germany, for example, where statistics have been accumulated with a care that only their pre-war officialdom was capable of, we find that in 1816 the consumption of meat was 30 (pounds, *per capita,* per year); in 1840, 48; 1873, 65; 1892, 72; 1900, 102; and 1912, 115. At this rate only a multiplication of great wars will send the curve on the decline again.

What are we to argue from these statistics? Certainly not that meat is good for us because we eat more and more of it with each succeeding year. As well argue that candy is, because the amount consumed is still on the increase; and yet, obviously, too much candy is harmful to the system.

How are we to solve this perplexing problem? Some years ago, Professor Chittenden, the Yale physiologist, performed experiments on himself, on Yale athletes, and on a number of soldiers, that led him to conclude that a diet containing as little as one-fifth the usual amount of protein was sufficient for all wants. The criticism that the experiments lasted but a few months, and that therefore

no conclusion drawn from them could be applied, no longer holds valid since the work of Dr. Hindhede, to whom we shall now turn.

Hindhede and a low protein diet. Hindhede was brought up in simple circumstances in Jutland, Denmark. Breakfast consisted of milk porridge and "beer-soup"; lunch, thick slices of bread, with a little butter, and sometimes a few thin slices of meat; and dinner, porridge, milk, cabbage, pea-soup, potatoes and bacon, sometimes fish, "and meat very rarely." The main dish was potatoes; the eating of large quantities of them was much encouraged. Upon this menu Hindhede and those around him grew up and flourished. Then, when sixteen years old, he went to Copenhagen to study. There Professor Panum, a nutrition expert, informed a class of which Hindhede was a member that the minimum amount of protein that would suffice to support life in an adult man was 120 grams (four and one-fifth ounces) per day. Panum further pointed out that since vegetable proteins are difficult to digest, and that therefore very large quantities of vegetables would have to be consumed to make up 120 grams of protein, it was necessary to obtain this protein in large measure from the animal kingdom. This was simply another way that the good professor had of emphasizing the importance of a liberal supply of meat in the diet.

This professorial advice clashed violently with Hindhede's early experiences. He himself was a youth of more than the average vigor, and his fellow West Jutlanders exhibited an energy that was actually "prodigious; they worked from 14 to 16 hours per day." What was true of the West Jutlanders was true of the Irish and the Japanese. "The Irish, who are notoriously potato eaters, are very virile, and in America, where they are often to be seen serving as policemen, their physical appearance is very imposing." The Japanese, whose diet is so largely vegetarian, possess uncommon powers of endurance. Prodigious West Jutlanders, Irish-American policemen, and hardy Japanese, all belied the teaching of Professor Panum.

But Panum was a highly respected professor and full of knowledge. It would not do for a young medical student lightly to brush aside so eminent a scientist's opinion. Hindhede therefore decided to follow Panum's advice for a time. He ate in cheap restaurants in Copenhagen, and ordered double portions of a main course, so as to be sure to get more than the minimum amount of necessary protein, particularly meat. But with time he grew less muscular and weaker. When he returned to his native Jutland, Hindhede returned to butter, bread, potatoes, sugar and fruit. The transformation was astounding. Despite much vigorous physical exercise, such as gardening and cycling, his

health, which had become poor in Copenhagen, was all that one could desire.

"These experiments, which were afterwards repeated with many variations, had convinced me of one fact, and that was that the little story of four and one-fifth ounces of protein is nothing but sheer fable; since which time—now some sixteen years ago [this was written in 1913]—very little meat is eaten in our house; most days we have none at all; and I am always exhorting my children to eat plenty of porridge, bread and potatoes, and very sparingly of meat, eggs, etc."

Hindhede's interpretation of his experiences is not above criticism. On the face of it, eating meat in cheap restaurants and falling sick does not necessarily imply that you have indulged in an overabundance of protein, but that you have eaten meat of poor quality. And then again, leaving dingy city quarters for the open country, working in your garden instead of poring over a volume, and eating bread, fresh butter, potatoes and fruit, instead of what you can get in a third or fourth-rate restaurant, would improve the health of any man. While, therefore, this account of Hindhede proves little, and his interpretation is misleading, he did draw two conclusions that are of great importance: the average man consumes more animal protein, particularly in the shape of meat, than is necessary, and he consumes less fresh vegetables and fruit

than is necessary. At one time Hindhede minimized the importance of milk, and still lightly brushes aside the function of eggs in nutrition. The outcome of recent vitamine studies has had the effect of placing milk and eggs, particularly the former, in the very forefront of nutritional requirements.

Milk and eggs, and to a less extent, bread, are rich in protein. Most of the protein requirements—all, in fact—can be derived from these foods; little, if any at all, need come from meat. Metabolic studies have shown that not proteins as such, but certain of their decomposition products, the amino-acids, are essential in the nutrition and growth of cellular structure. The various proteins differ from one another in the number and amount of these amino-acids that they yield when decomposed in the digestive tract. Experiments have shown that the essential amino-acids are more abundant in animal than in vegetable proteins. These animal proteins, however, need not be sought in meat; they are present in milk and eggs, to say nothing of other essentials, such as vitamines, which these foods contain.

Food in Denmark during the Great War. As early as 1911 the Danish government, influenced by a committee from the Department of Agriculture, placed a well-equipped laboratory at Hindhede's disposal, and when, during the late War, the

Allied blockade began to affect neutrals as well as enemy countries, Hindhede was placed in charge of the supervision of food in Denmark. He and officials under him were guided by the following conclusions, the result of extensive experimental work in Hindhede's laboratory: no attention was to be paid to the protein minimum; "it was held that the minimum was so low for man that it could not be reached, provided sufficient calories were furnished." While the value of fat was not to be underestimated, "it was not considered as being necessary." Bran was to be regarded as a valuable food, and one "well digested by man."

"As research has also shown that man can retain full vigor for a year or more on a diet of potatoes and fat, reliance was placed on our potatoes and the large barley crop, which was given to man and not to pigs, as heretofore, with the result that the pigs died of starvation but the people received sufficient nutrition. Furthermore, we ate all our bran ourselves. We not only ate whole rye bread, but we mixed all our wheat bran with the rye flour and were able to bake good bread in this way. The Germans were unable to bake good rye bread. Their bread was too sour and too soggy. We were fortunate in having more than a hundred years of experience in this direction. Our principal foods were wheat bran, barley porridge, potatoes, greens, milk, and some butter. Pork pro-

duction was very low; hence the farmers ate all the pork they raised, and the people of the cities or towns got little or no pork. Beef was so costly that only the rich could afford to buy it in sufficient amount. It is evident that most of the people were living on a milk and vegetable diet."

What were the results? Hindhede has tabulated the number of deaths (per 10,000 of the population) in Denmark since 1900. They are as follows:

Year	All diseases	Epidemic diseases and tuberculosis	Other diseases
1900	152	46	106
1901	151	41	110
1902	131	30	109
1903	142	34	108
1904	137	36	101
1905	148	41	107
1906	144	33	111
1907	145	31	114
1908	152	35	117
1909	142	31	111
1910	135	26	109
1911	148	32	116
1912	138	30	108
1913	130	28	102
1914	133	27	106
1915	134	26	106
1916	145	35	110
1917	123	33	90
1917–1918	99	27	72

Food restrictions came into force in March, 1917, so that the year 1917 covers part of this period. The dates 1917–1918 represent from October 1 of one year to October 1 of the next—a period during which the restrictions had become very severe.

Now let us interpret the table. The figures in the column headed "all diseases" show, with one or two exceptions, a pronounced decline as we pass downwards. This is what might be expected; mortality tables in every civilized country will more or less duplicate these figures. The lower death rate is, of course, due to our ever-increasing knowledge of a number of diseases. When, however, we subdivide the figures in the first column in such a way as to include all those who died from epidemic diseases and tuberculosis under one heading, and "other diseases" under another, then some striking facts are brought out. Like the figures in the first column, those in the second show a gradual decrease; but those in the third column are practically stationary, *except for the last two years.* The data in the second column are what might have been anticipated. Decreased deaths are primarily due to decreases in the number of deaths from epidemic diseases. Since 1900 our knowledge of "other diseases" has not improved greatly; the third column shows figures that are more or less constant.

But why the sudden drop in 1917 and 1917–1918? It can be attributed, claims Hindhede, to but one

thing: to the kind of food that the Danes were *forced* to eat during this time, and particularly to the low protein diet.

These results, however, may be interpreted differently. "It must be remembered," writes Hindhede, "that we took the cereals and potatoes from the distillers so that they could not make brandy, and one-half of the cereals from the brewers, so that the beer output was reduced one-half." This immediately suggests that decreased deaths due to diseases other than epidemic and those due to tuberculosis, may have been due to a decreased consumption of beer and brandy. If, then, these statistics do not easily convert us to Hindhede's views, they certainly prove that meat, and large quantities of protein, are wholly unnecessary in the diet.

Mineral salts. These are the inorganic constituents popularly known as "ash." Most of the elements included under this heading, such as sodium, potassium, and magnesium, are apparently needed in such small quantities that a person fails to get the amounts needed only in acute starvation. The fats, proteins, carbohydrates, and water, all contain small quantities of mineral matter, and only a total deprivation of food will stop the intake of these inorganic salts. But there are some inorganic constituents, like calcium, phosphorus, and iron, that man needs in fairly large quantities, and a poorly selected or restricted diet may be dis-

tinctly deficient in these elements. How serious the situation is may be gauged from Professor Sherman's conclusion, reached after an extensive investigation, that the average American dietary is of such a nature as to make it far more likely that people will suffer from an insufficiency of phosphorus than from an insufficiency of protein. And it must be remembered that diseases due to malnutrition are no less severe because the cause is to be traced to the absence of inorganic salts from the diet, rather than to the absence of protein or carbohydrate. All are essential, ash as well as organic matter. In the plant world the farmer has long ago been taught to use an artificial fertilizer to make good the deficiencies of phosphorus, nitrogen, and potassium in the soil; another great war may make it necessary to introduce fertilizers into man's diet.

We do not intend to discuss all the various inorganic constituents found in the body and supplied by the food we eat. We shall merely confine ourselves to four elements that experience has taught us may be present in deficient amounts—iron, calcium, phosphorus and iodine.

Iron. Though all the cells of the body contain traces of iron, the largest amount is found in the hemoglobin (blood pigment) of the red blood cells. The possible interrelationships of the weak, the pale, and the anemic persons, and the probable re-

lationship of these to lack of hemoglobin, has led to the development of the extensive field of iron therapy. As with vitamines and other scientific studies that strike the public fancy and the advertiser's eye, iron tonics have for a long time occupied a generous share of the public's curiosity. Plutarch's Pills for Pale People need to be satirized as have been Broxopp's Baked Beans for Babies. The tonics seldom do any good, and very often do very much harm. Whatever good they may do is probably due to things other than their iron content—and to an undiminished faith in the integrity of the advertiser.

What are the possibilities of an iron cure in anemia? How may the iron content of the blood be increased? The Swiss and German schools, headed by Bunge and Abderhalden, have little faith in the efficacy of adding iron compounds to the diet, except in so far as they may act as general cell stimulants. Abderhalden has made the very pertinent observation that all this controversy as to how much, and in what form, iron should be taken, is really beside the point, since iron is but one of several factors necessary for hemoglobin formation. Hemoglobin is a complicated iron-protein compound, and it is just as necessary to procure the essential constituents that go to the formation of the protein part of the molecule as it is to procure the needed iron. It seems wisest, therefore, to get

the element from the natural foods containing it. An educational poster prepared by the propaganda department of the American Medical Association —an eyesore to the advertising fraternity—reads, "Do not be misled by the claims of high iron content for certain advertised foodstuffs; many foods contain them." And then it proceeds to give a table of foods rich in iron: egg yolk, beans, entire wheat, lean beef, nuts, prunes, spinach, etc. The egg yolk is particularly rich in iron.

The amount of iron in the body is not large—about one-tenth of an ounce. Not more than one two-thousandth of this amount is eliminated daily, so that the actual quantity of iron needed is small; but it must also not be forgotten that one of the richest of iron-containing foods, egg yolk, contains but one part of iron for every 12,500 parts of yolk.

Milk is comparatively poor in iron. This seems rather strange at first sight, when we remember that milk is the sole source of nourishment of the infant. Light has been thrown on the subject by the discovery that, weight for weight, the infant's tissues are much richer in this element than are those of the adult. The suckling animal stores iron, which is obtained from its mother even before birth, and makes use of this reserve supply during the first few months. This, of course, necessitates offering the mother food abundant in the element.

Calcium. "The ordinary mixed diet of Euro-

peans and Americans," writes Professor Sherman, "at least among dwellers in cities and towns, is probably more often deficient in calcium than in any other element." If true, this statement calls for careful reflection. Two per cent of the body weight is in the form of calcium, and more than 99 per cent of the total amount is found in bones. In the structure of bones calcium and phosphorus fight for supremacy: both are essential; when either is present in insufficient amount, or when either one or the other is imperfectly assimilated, we often get the picture of a "rickety" child—a child whose bones are soft and flexible. The most abundant source of calcium (or lime, as it is popularly called) is milk and its products. A little over a pint of milk a day is enough to supply all calcium needs.[2] Vegetables, such as cabbage, turnips, and carrots, and fruits, such as the orange, are also rich in calcium. It is of importance to remember that bread and meat are particularly poor in this element—another reason for adopting a varied diet.

As with iron, so with calcium: the pregnant and the nursing mother need a relatively large quantity of this element. Let the slogan be "eggs for iron and milk for lime." [3]

[2] This should be increased to a quart a day in the case of children.

[3] In certain diseases the doctor may advise his patient not to eat eggs or drink milk. If this is but a temporary procedure, the

Phosphorus. Much of what has been said about calcium applies to phosphorus: both are essential elements; both take an active part in bone formation; and the lack of either may manifest itself (in the child) in the disease called "rickets." The phosphorus compounds of the body are more diverse than those of calcium. Peculiar substances, known as lipoids, and found in every cell, contain phosphorus as a constituent. These lipoids are present in large quantity in brain tissue; hence "phosphorus for the brain." Adding phosphorus to the diet no more converts the fool into the wise man than adding iron to the diet makes the sick man healthy; and yet phosphorus is present in brain tissue, and iron in blood.

Forbes, an authority, says: "If the natural organic phosphorus compounds [in foods] are not of superior usefulness [to inorganic compounds], then other nutrients associated with them in the natural foods *are* essential, and the result is to put a new emphasis on the value of the natural organic foodstuffs, as compared with inorganic or artificially synthesized nutrients and certain manufactured goods." Cheese, eggs, beans and peas are rich in the naturally occurring phosphorus sub-

patient need not worry. If, however, the eggs and milk are eliminated from the diet for a considerable length of time, then it becomes necessary for the physician to select the diet of his patient with the utmost care, so as to insure all elements that are indispensable.

stances. The egg, please notice, is rich both in iron *and* phosphorus.

To sum up, we may say that since the body needs certain minimal amounts of inorganic constituents, an ample supply of these, preferably in the form of a mixed diet, is necessary. Further, such diseases as anemia and rickets, which are superficially attributed wholly to a lack of the elements iron, phosphorus, and calcium, are of a more complex nature, and tonics help but little, if at all. The far more rational method of treatment is by an entire reorganization of the dietary regimen.

Iodine. The importance of iodine as a constituent of the thyroid, which in turn regulates much of our metabolic activities, has only lately been emphasized.[4] The prevalence of goiter among children and adults in the Great Lakes section of this country illustrates how the body may receive an insufficient supply of iodine; for the administration of this element (usually in the form of one of its compounds, such as sodium iodide) brings about a cure.

Vitamines.[5] Vitamines—the word "vitamine" was coined by Dr. Funk—are substances present in small quantities in most of the foods we eat. They are essential to life. A diet which includes

[4] See the author's book, *Glands in Health and Disease* (E. P. Dutton and Co., N. Y.).

[5] See the author's book, *Vitamines: Essential Food Factors* (E. P. Dutton and Co., N. Y.).

milk, vegetables, and fruit in fair abundance assures an adequate supply of these necessary substances.

Our advertising friends, with that aptitude for bamboozling the public which they possess, have given these vitamines an undue prominence. Yeast preparations have flooded the market. The most remarkable and unheard-of properties have been attributed to them. As a matter of fact, these vitamine preparations are of no more value than the many patent medicines that occupy so many shelves in drug stores: they are only less harmful.

The necessary vitamines are most easily obtained from the natural foods that man is accustomed to eat. In our own country only a very slender purse, or a very one-sided diet, may fail to procure us enough of these substances (in the shape of the food we eat). The problem is not solved by the administration of yeast tablets; these cost several hundred per cent more than milk, and are far less efficacious. In Russia, Austria, and Germany, part of the malnutrition is undoubtedly due to lack of vitamines, which in turn is the result of a diet insufficient in amount and limited in quantity. But there again the solution lies not in the supply of yeast tablets, but in an improvement of the food situation. Beriberi, a vitamine deficiency disease, at one time rampant in the Philippines and in Japan, was eradicated not with yeast tablets, but

by the substitution of whole rice for the milled variety. Scurvy is prevented not with vitamine tablets, but by the administration of orange juice.

So full of frailties is man that even the more intelligent will read these sentences and then go to the nearest drugstore for Ploxom's Pills or Voxom's Vitamines. There never deserts him that vague feeling that *possibly* there is something in it. On the strength of a vague possibility, Ploxom makes his millions and Voxom his tens of millions, and, quite incidentally, man accelerates the ruin of his entire digestive system.[6]

Having said so much, we shall not deny that the physician in treating some of his hospital patients by the administration of vitamine concentrates may, and sometimes does, bring about cures. Here the analogy is one of an underfed or ill-fed rat, which responds to vitamine treatment, and not a normal rat, living on a normal diet, which shows no additional improvement when vitamines are administered.

Water. Water, like oxygen, is an essential food, but like it, is usually ignored in discussions of food. We have already given what appears to us

[6] The various yeast preparations have been advocated as "removers of boils," etc. There seems to be little doubt that yeast acts as a mild laxative, and whatever "cures" are obtained are probably due to this property. All else is the merest of conjectures.

the most probable reason for this: there is no air-tax, and the water-tax is still negligible.

An elementary analysis of our body shows that four-fifths of it (by weight) is water. Many and complex as are its functions, the one that is most readily grasped is that it keeps food and body products in solution, and so facilitates their ready transportation from one part of the body to the other.

Recent studies have brought out two important facts: contrary to what many people believe, water drinking at meals is not harmful; it, in fact, stimulates the digestive juices; and most men drink too little water. Four to five tumblers a day, apart from intensifying the flow of secretions, materially aids in flushing the intestines.

References

[*J. A. M. A.*=*Journal of the American Medical Association*]

Much of what is discussed in this chapter will be found, in amplified form, in my book, *Vitamines: Essential Food Factors* (E. P. Dutton and Co., N. Y.), chapters I–VIII. The fundamental work of Lavoisier is entertainingly discussed by Graham Lusk in his Pasteur lecture, "Some Influences of French Science on Medicine," *J.A.M.A.*, volume 76, page 1, 1921. Dr. Carter is responsible for an ar-

ticle on the Pirquet system of nutrition (*J.A.M.A.*, volume 77, page 1541, 1921). The calorific requirements of children are discussed by L. E. Holt, in the *American Journal of Diseases of Children,* volume 21, page 1, 1921, and volume 23, page 471, 1922.

Two general references to this chapter are H. C. Sherman: *Chemistry of Food and Nutrition* (Macmillan Co., N. Y.); and H. S. Carter, P. E. Howe and H. A. Mason: *Nutrition and Clinical Dietetics* (Lea and Febiger, Philadelphia), earlier chapters.

The burning topic as to how much protein is to be included in the diet is discussed by M. Hindhede in his *Protein and Nutrition* (Ewart, Seymour and Co., London). Here the reader will find not only an account of Hindhede's own experiments, but also those due to a much earlier worker, Voit, and to Chittenden. Hindhede's article on "The Effect of Food Restriction During War on Mortality in Denmark," *J.A.M.A.,* volume 74, page 381, 1920, and on "Alcohol Restriction and Mortality," *British Medical Journal,* Aug. 12, 1922, should also be consulted.

For the inorganic constituents in diet, consult Sherman (referred to above), chapters 9, 10 and 11; also T. B. Osborne and L. B. Mendel, "The Inorganic Elements in Nutrition," *Journal of Biological Chemistry,* volume 34, page 131, 1918; and

editorials in the *J.A.M.A.*, volume 75, page 1004, 1920, and volume 78, pages 512 and 1460, 1922.

The subject of vitamines is treated in my book (see above). The possible efficacy of yeast preparations is discussed under the heading of "New and Non-Official Remedies," in the *J.A.M.A.*, volume 79, page 135, 1922.

Those who read German may be referred to Hindhede's very latest volume, *Die Neue Ernährungslehre* (Emil Pahl, Dresden).

CHAPTER II

WHAT TO EAT: SOME COMMON FOODS

Milk and its products. We have already stressed the desirability of a varied diet. Very often ignorance, sometimes pecuniary considerations, and at other times social conditions (such as those existing in Europe to-day), result in giving us anything but a varied diet; the inclusion of milk then becomes more than ever imperative. Milk is a corrective: it makes up for deficiencies in other foods. How true this is, is seen in the present distressing condition of the peoples of Central Europe and Russia—and China and India, and other more remote parts of the world—where milk is lacking; and in the restoration to health that is invariably witnessed when, through a Hoover or through the Society of Friends, milk finds its way to the homes of these unfortunates.[1]

There is much in milk that needs elucidation—

[1] "The average monthly supply of fresh milk amounted to more than 27,000,000 liters (quarts) in 1913 for Vienna alone, but in October, 1918, this quantity had decreased by 89 per cent. to only 4,500,000, or 150,000 daily. When, however, owing to the peace treaty, the chief pasture grounds were cast off from Austria, no more than 90,000 liters each day arrived in Vienna in 1919, although the average minimal requirement of milk for infants' hospitals and the severely sick amounted to more than 750,000

F. G. HOPKINS, PROFESSOR OF BIOCHEMISTRY AT THE UNIVERSITY OF CAMBRIDGE. PROFESSOR HOPKINS HAS BEEN EXTREMELY SUCCESSFUL IN APPLYING CHEMISTRY TO ELUCIDATE VARIOUS PROBLEMS IN PHYSIOLOGY.

why, for example, mother's milk is so much better for the child than cow's; but we have learnt this in recent years: that its proteins are high in the biological scale (of high physiological value, that is), and that it contains all the three known vitamines. It lacks sufficient iron, and is deficient in the vitamine that prevents scurvy (vitamine *C*), but it contains protein, fat and carbohydrate, and vitamines apart from the *C* variety in abundance, and mineral salts in fair quantity.

The conclusion is inevitable: whatever you do, do not fail to drink two to three glasses of milk a day.

liters a day. In the summer months of 1919 and 1920 conditions went from bad to worse, because a large proportion of the fresh milk turned sour before it reached the city, as there were no refrigerators or ice-cooled vans available for transport. Out of 113,256 liters coming to Vienna daily in August, 1921, 40 per cent. became sour and thus unfit for infant feeding. Before the war the per capita quantity each day was 0.41 liter (a little less than a pint); in November, 1918, it went down to 10 per cent. of this quantity; in July, 1920, it dropped further to half of that quantity (0.02 liter); in July, 1921, it was 0.04 liter again, and it remained approximately the same until the end of the year, so that only one tenth of the peace ratio was available. In the Alpine districts, the conditions were also far from satisfactory, for there too the present quantity of milk available is no more than from one fifth to one third of that deemed as a minimum in 1913. These figures explain the most distressing spread of rickets and underdevelopment of infants during the last few years, and it is not likely that a radical change will take place within reasonable time. The rural population in Austria has turned from the milk industry and pays more attention to slaughtering animals and to the crops, because these pay much better; on the other side, the former milk districts no longer belong to this country, and the import of the milk to Vienna is, at the present exchange rate, quite impossible."—*Journal of the American Medical Association.*

But drink it how, you may ask; in the raw, pasteurized, or boiled condition? Were it not for the readiness with which bacteria multiply in milk, the raw condition would undoubtedly be the best. Boiling milk is the quickest and safest way of getting rid of bacteria; this is practised very largely on the Continent. We in this country find pasteurization a better substitute. Since pasteurization does not require heating to as high a temperature as does boiling, and therefore does not destroy all bacteria, it has less influence in changing the composition and the taste of milk, and is less apt to affect the vitamines. The fact that a city like New York is supplied with pasteurized milk, with gratifying results to the health of the population, shows what pasteurization (heating the milk at 145 degrees Fahrenheit for 30 minutes), coupled with scrupulous cleanliness in pasteurizing plants, will do. "Scrupulous cleanliness" needs emphasizing. Pasteurization would not be the success it is if rare cleanliness in the plants were not the order of the day. We start, therefore, with a minimum number of bacteria, and these are further prevented from multiplying by keeping the tanks at a low temperature (50 degrees Fahrenheit).

Of course, a much easier way of preventing the growth of bacteria would be to add some preservative to milk, such as boric or salicylic acid, or formalin. There is, however, a very decided objection

to these preservatives: they are injurious to health; hence the stringent laws everywhere against their use.

Grades of milk. The difference between the grades of milk, such as grade "A" and grade "B," is not one of composition but of method of handling. With grade "A" the various operations—filtering, cooling, pasteurizing—are done in different rooms; with "B," they are all done in one room (except for the washing). And the "A" bottle has an extra cap covering its mouth, whereas the "B" has not!

The certified milk is obtained from tested cows, and is carefully supervised by the health authorities who, in New York State, require that the milk contain less than 30,000 germs per cubic centimeter (the ordinary "good" milk contains 50,000 and more), and that it contain at least four per cent of butter fat.

Butter milk, obtained as a by-product in butter making, is much like skim milk in composition—that is, it is low in fats—but since cream is usually allowed to sour before churning, the milk has a sour taste. Whey is what is left after the cheese is removed (in the course of cheese manufacture). It contains the sugar and minerals of whole milk, but is not as nutritious as skim or butter milk.

Evaporated or condensed milk is a variety of milk that has had much of its water removed by evaporation (under reduced pressure, so as to pre-

vent changes as much as possible). The desiccated or dried milk contains no water at all, or practically none.[2] Since cow's milk contains more protein than that of the mother but less sugar, we dilute cow's milk and add sugar. The details are left to the physician in charge.[3]

Sour milk and the Metchnikoff theory of old age. The souring of milk upon standing is due to the conversion of milk sugar (lactose) into lactic acid by bacteria from the air. Butter milk is perhaps the best known example. Various types of sour milk are manufactured by inoculating milk with a definite strain of bacteria.

Metchnikoff, the famous Russian biologist, had noted that many peasants in Europe, particularly those in Bulgaria, lived to a very old age, and, strangely enough, a very large part of their food consists of sour milk. It was but a step to connect the drinking of sour milk with the development

[2] Drs. Clark and Collins, of the U. S. Public Health Service, have been investigating the value of a number of dried milk powders in infant feeding. They have come to the conclusion that some of the milk powders are of distinct value. (Write to the U. S. Public Health Service, Washington, D. C., and ask for *Public Health Report*, Volume 37, page 2415, Oct. 6, 1922.)

[3] The composition of cow's, goat's and human milk, as given by L. L. van Slyke, the dairy expert of the N. Y. State Agricultural Experiment Station, is (in per cent):

Compound	Cow's milk	Goat's milk	Human milk
Fat	3.9	3.8	3.3
Milk sugar	4.9	4.5	6.5
Proteins	3.2	3.1	1.5
Salts	0.9	0.9	0.3

of a healthy body, and it required another step to attempt an explanation. Metchnikoff developed the theory that the putrefactive bacteria that develop in the intestine produce toxic products that are absorbed by the system and sooner or later poison it—give rise to hardening of the arteries and general senility. He claimed that the drinking of sour milk developed a non-toxic acid bacteria that in time supplanted the putrefactive bacteria.

These views of Metchnikoff have not been substantiated. It has been proved, in fact, that the particular bacillus with which he experimented, the *bacillus bulgaricus,* never can be implanted in the intestine. However, the use of sour milk has greatly increased since his time, and many clinicians are of the opinion that it may be used to advantage in various gastro-intestinal disorders.

Lately Professor Rettger, of Yale, has inoculated milk with *bacillus acidophilus,* and finds that it can be readily implanted in the intestine, supplanting, in turn, other and toxic varieties. He makes no such claims for it as Metchnikoff made for his *bacillus bulgaricus;* on the contrary, his excessive conservatism is even a trifle irritating; but he has been able to relieve cases of chronic constipation (with so-called auto-intoxication), diarrhea, and colitis (inflammation of the colon). The results are very encouraging, but the entire subject is still in a very experimental stage.

Milk from various animals. In this country, "milk" without further qualifications refers to cow's milk. Few of us drink the milk of another animal, and in most of us a very disagreeable sensation is aroused at the thought of milk other than cow's. Such ideas and sensations are little more than the result of acquired taste. The goat in Spain and Italy; the mare in Russia; the reindeer in the Arctic; the llama in South America; the camel in Arabia; and the buffalo in India—the milk of all these animals is used as food. Though exhaustive experiments are wanting, there does not seem to be any material difference in quality among these varieties of milk; each variety has its adherents. This we can say: the milk of any one species is best for the young of that species; from which it follows that the best milk for the infant is mother's milk.

Cream and butter. Cream and butter contain large quantities of the fat in milk; cream usually contains as much as twenty, and butter as much as eighty per cent. The cream is most easily obtained by pouring off the top portions of milk that has been standing in a cold place for some time. The more economical method, and the one more adapted for commercial purposes, is by making use of the separator, a revolving machine making several thousand revolutions per minute. The heavier portion, the skim milk, stays near the periphery, and

is drawn off at one end, and the lighter, the cream, collects nearer the center, and is drawn off there.

Cream and butter are valuable fattening foods, and are rich in one of the essential vitamines (vitamine *A*).

Ice cream. Ice cream is merely cream mixed with sugar, sometimes with starch and eggs, and often with gelatin. It is flavored with extracts of vanilla, chocolate, etc. We in this country consume more of it than the rest of the world put together—some 150 million gallons a year. A nourishing food ice cream undoubtedly is; but the excessive quantities of it that most of us consume, containing as it does large amounts of sugar and flavoring material, coupled with a quality of product which often is very indifferent, leads to much intestinal disorder.

Butter. In the preparation of butter the cream is allowed to ripen, that is, to stand until a decided acidity is developed. The acidity is due to the production of lactic acid by the action of the bacteria of the air, or of specially implanted bacteria, on the milk sugar. The proper ripening develops the desirable flavoring qualities of butter. The next process, the churning or agitating, separates the butter fat still more completely from the other constituents of milk. Both the ripening and the churning should be done at low temperatures. The final process, the working, consists in washing the

butter with water, and then removing this water by squeezing. Salt is often added to improve the flavor, but chiefly to add to its keeping qualities. It may be taken for granted that, as a rule, the unsalted butter is fresher than the salted; and whenever possible, the former should be procured. There is no reason why, if salted butter is preferred, salt cannot be added to the sweet butter.

Cream and butter both have high calorific value; they both—as has already been noted—contain one of the essential vitamines; and, unless taken in considerable excess, are easily digested and absorbed. They, therefore, belong to our very valuable foods. High in content of fat, they should always be included in the diet of persons who are underweight, and be given in small quantities, but not excluded altogether, to persons who are overweight.

Butter substitutes. The various butter substitutes, such as margarine and butterine, are made from fats other than milk fat, though often a little butter is added. Lard, cotton-seed, peanut and sesame oils are all used for the purpose. The process of manufacture is a complicated one. In fuel value these butter substitutes are not inferior to butter, but they do not contain the vitamine that butter does, nor do they taste as well. However, since milk supplies the vitamine found in butter, there can be no objection to a diet which includes milk and margarine in the place of milk and butter.

Cheese. Cheese, in addition to containing fat (about 30 per cent), also contains protein (about 20 per cent). The protein is mainly the casein of milk. It is undoubtedly one of the most nutritious foods we have, and, if regularly incorporated in our diet, easily takes the place of meat. The eating of cheese should always be encouraged.

Cheese is now manufactured by the addition of rennin (rennet) to milk. Rennin represents an impure preparation of an enzyme found in the stomach of calves (and in other animals, including man, but not in such quantity), which has the property of coagulating or curdling milk. The preparation of junket represents this process in miniature. The curd is beaten to break up the lumps, squeezed through cloths to get rid of adhering liquid, and stored to develop flavors—a process in which the bacteria present in the cheese take an active part.

Cottage cheese, cream cheese, limburger, cheddar, roquefort, etc., are varieties which depend for their preparation on method of manufacture, on temperature, and above all, on the type of curing. In many of them, during the ripening process, molds and bacteria develop, and products which cannot be distinguished from those obtained in putrefaction are often obtained. It is one of the anomalies of our make-up that some of us should consider limburger a delicacy.

Eggs. Like cheese, eggs are rich in protein and fat, and like cheese again, may largely replace meat. Both cheese and eggs are poor in carbohydrate, and therefore the addition of bread or other starchy food (a vegetable) to the diet is desirable. Eggs contain around 13 per cent of protein and 10 per cent of fat, with appreciable quantities of phosphorus, and smaller quantities of the no less valuable calcium and iron. They are rich in vitamines. The fats in eggs are mixtures of true fats and lipoids, the latter resembling fats in physical properties, and at least one variety, lecithin, in chemical properties. Much of the phosphorus of eggs is found in the form of this lecithin. We have already mentioned elsewhere (page 9) that the lipoids are present in every cell, and are particularly abundant in brain tissue, which attests their importance.

With regard to the digestibility of eggs, much depends upon the individual. No two persons seem to have the same digestive capacities, not only for eggs, but for other foods. This is something that must forever be kept in mind. But it may be said in a general way that soft-boiled eggs are more readily digested than hard-boiled, and that an omelet is a form of egg easily digested. Experiments seem to show that soft-boiled eggs do not remain in the stomach as long as do hard-boiled—an indication that the former is more easily attacked by the gastric juice than the latter. But the mere

fact that hard-boiled eggs remain longer in the stomach means little in the case of the normal, healthy individual, and assumes significance only where health is impaired. The raw egg is much on a plane with the soft-boiled. The omelet is easily digested because of its fluffiness; that is, to speak in more technical terms, the surface area of the egg is increased—and an increase of surface area always accelerates chemical action (in this particular case, the action of the pepsin of the gastric juice on the protein of the egg). It should be borne in mind that much of the protein, and almost the entire fat digestion, is carried on in the small intestine (see page 181), and that a consideration of stomach digestion is but a fraction of the story.

Cold-storage eggs, when not in a putrefied condition, are, chemically, practically indistinguishable from fresh eggs, and, so far as one can learn, are as easily digested. To many people they are palatable, and to most, wholesome; but it would be stretching our scientific knowledge beyond reasonable limits to assume that there is no difference between the two grades of eggs. Man knows from experience that there is a difference; and in this instance, his own bitter experience is the better guide. "Fresh preferred" is a motto also to be remembered with foods other than eggs.

We have given here an instance in which it seems to us that man's experience serves as a more accu-

rate guide than the analysis of the chemist. We have now, however, to refer to something which ought to change the you-really-know-nothing attitude that many a layman assumes towards the scientist. White eggs, cry some, are fresh and wholesome, brown eggs are not; others, with equal conviction and an equivalent of ignorance, say just the reverse. The average New Yorker represents one school, and the average Bostonian, the other. As a matter of fact, no difference in quality, based on the presence or absence of pigment in the shell, is warranted. Freshness and wholesomeness depend upon other properties. This, however, does not deter the dealer, who often knows better, from reaping a rich harvest by trading upon the ignorance of the public.

Meat. A recent Interallied Council of Physiologists gave out this statement: "It is not thought desirable to fix a minimum meat ration, in view of the fact that no absolute physiological need for meat exists, since the proteins of meat can be replaced by other proteins of animal origin, such as those contained in milk, cheese and eggs, as well as by proteins of vegetable origin." This statement deserves much wider circulation among the masses than it has so far received. At first sight it seems like an endorsement of Hindhede's views (see page 13), but as a matter of fact it is not really that. This international group of physiologists

attribute to proteins a more important rôle than Hindhede seems to give them; they are of the opinion that the minimal protein needs are more than those suggested by the Danish investigator; but they do agree with him in believing that meat is not a necessity. The animal proteins in milk, cheese and eggs, as we have already emphasized, have fully the biological value of meat proteins, and meat as a food has several distinct disadvantages. The claim has been made, and it seems with good reason, that much intestinal putrefaction, resulting in gastro-intestinal disorders, may be traced to excessive meat eating.

Like eggs and cheese, meat is rich in protein (about 20 per cent) and very often in fat (8 to 16 per cent). It contains a little phosphorus and traces of iron, calcium, etc. It also contains purine derivatives that go under the name of extractives, to which is attributed much of man's love for meat. Purines are precursors of uric acid, a substance associated with the disease known as "gout" (see page 144); hence the "gouty" person is advised to avoid meat. Since meat is practically devoid of carbohydrate, the consumption of large quantities of it, and the absence from the diet of such a compensating factor as vegetables, often gives rise to acute constipation.

Test tube experiments do not show any essential difference in the digestion of the protein in meat

and that in milk or eggs; yet clinical observation, and our own daily experiences, lead to different conclusions. We are told in explanation that the fibers of meat are tough, but that is at best a partial explanation, though it can be applied to explain why chicken is more easily digested than beef. The chicken, we say, is tender, the fibers smaller and less resistant.

If the excessive quantities of meat consumed are to be discouraged, what are we to say of such meat products as go under the name of delicatessen, the hodge-podge of the slaughter house? In delicatessen we have an excellent illustration of how an appetizing dish does not necessarily prove a wholesome one. Very much the same, and perhaps even more, may be said of canned meats.

The distinction that the public makes between white and red meats needs modification. Chicken and pigeon, to be sure, are more easily digested than beef, but clinical experience does not teach us that this is true of duck, turkey, and goose. Neither have the differences, where they do exist, anything to do with the color. The color is no more a factor than is the color of the egg's shell a criterion of freshness.

Products such as soup (animal) and beef extract (such as Liebig's) are watery extracts containing very little protein, but most of the salts and the

purines of meat. From what we have said of the purines, we can now understand why these watery extracts act as stimulants to the flow of the digestive juices.

Fish. In composition, fish and meat have much in common. Both are predominantly protein foods, both contain little carbohydrate, and both vary in their fat content. The protein in fish may range from 14 per cent in flounder to 22 per cent in salmon; the fat, from less than one per cent in cod to 12 per cent in salmon. The bass, bluefish, cod, flounder, trout, and weakfish are low in fat, and more easily digested than halibut, herring, mackerel, salmon and shad, which are high in fat.

On the whole, it may be said of fish that it is more easily digested than meat, and is certainly an excellent substitute for meat. The one serious objection to it is that it spoils so easily. Unless, therefore, one has access to really fresh fish, the better plan would be to substitute dairy products. Cold-storage fish and salted products cannot be condemned outright, since laboratory experiments have much to say in their favor; but, here again, experience, clinical and otherwise, teaches caution.

Shell fish, such as the mollusks (oysters, clams, mussels, and scallops) and crustaceans (lobsters, crabs, shrimps, and crawfish) are justly prized delicacies and are easily digested. They are, however,

a source of frequent danger owing to contamination. Remember how often the oyster bed and the sewage outlet are in close proximity.

Bread and grain products. We now come to the first of the foods so far discussed that is predominantly carbohydrate. The grains contain appreciable quantities of protein, to be sure, but, from the biological standpoint, they are poor in quality. Protein derived solely from bread would give rise to malnutrition, even though the amount ingested would exceed that demanded by a most liberal diet.

The percentage of carbohydrate in barley, corn, oats, rye, and wheat ranges from 58 to 71, and the per cent of protein, from 10 to 12. They contain smaller quantities of fat (from one and one-quarter to four per cent), and larger quantities (from 1.5 to 3.5) of mineral matter than do the protein-rich foods. They act, therefore, as excellent supplementary foods for eggs, meat, fish, and cheese.

Bread, the commonest of grain products, is made in this country from wheat, though the War has taught us the palatability of rye bread, a commoner article in Europe. Wheat contains a higher percentage of gluten than is found in other grains, and this gives those sticky qualities to wheat flour that are so prized by the baker and the housewife. But we have no experimental evidence to show that any one grain is to be preferred over any other.

Barley, in the shape of soup and barley water;

buckwheat, in the form of pancake; corn, as pop corn and sweet corn; oats, as oatmeal; and rice, illustrate the wide use of these products.

A slice of bread and a glass of milk have a value that few realize even at this day.

Vegetables and fruit. These are valuable for their mineral, cellulose, and vitamine contents. The cellulose gives the necessary bulk to the food and aids in the proper peristaltic movements of the intestines. Many vegetables, the potato, for example, are rich in starch. A few, such as beans, contain appreciable quantities of protein, though these are the exception.

It is not so very long ago that we were taught that a vegetable like the tomato is of little value as food, because it contains 90 per cent by weight of water. Since vitamines have come to the front, we have learnt that vegetables (and fruits) are rich in vitamines, particularly the tomato, which has been shown to contain all three vitamines—a record equalled only by milk.

What an array of substances nature provides us among fruits and vegetables! The potato, tomato, cabbage, cucumbers, radish, lettuce, carrots, spinach, peas, beans, etc., among vegetables; and the apple, pear, cherry, peach, plum, grape fruit, lemon, orange, berries, banana, fig, watermelon, etc., among fruits; all high in water content, to be sure; but high also in minerals, rich in vitamine,

with a cellulose and starch content that facilitate digestion. Notice, then, what an all-round diet should include: cheese, egg, meat or fish, for protein (and fat?); vegetables and fruit for mineral salts and vitamines; bread and cereals and sugar (in moderate quantities) for carbohydrates; and, to offset any deficiencies, milk, the corrective.

Sugar. The sugar (cane sugar) ordinarily used for sweetening is practically 100 per cent carbohydrate. If taken in moderate quantities (in tea or coffee), it is readily digested, and therefore becomes valuable as a food. However, if taken immoderately (in the form of pies and more particularly candies), it contributes to the condition known as the upset stomach. Where a liberal supply of vegetables is at hand, we need seek little carbohydrate in sugar; but why waste this advice upon the American, to whom sweets have become a necessity and are no longer a luxury!

Nuts. Due to their fairly high protein (from 6 to 25 per cent) and fat (from 5 to 70 per cent) contents, nuts have recently been advocated in the place of protein-rich foods. Successful experiments on animals have been carried out where the diet consisted of nuts, cereals, and vegetables. But caution is necessary when the attempt is made to apply the results of such experiments. Experience has taught us that nuts are not easily digested;

and it is doubtful whether the proteins have the same biological value as those of milk and eggs.

Beverages. Tea, coffee, and cocoa, true stimulants, affect the nervous system due to the presence of the alkaloid, caffein, or to substances that are chemically similar to it. Where the amount consumed is from one to two cups a day, the harm done is probably so small that it can hardly be measured. But coffee drinking in this country, like tea drinking in Russia and perhaps in England, has assumed huge proportions, and it is perhaps time to utter a word of warning.

We are all familiar with the student who drinks coffee to keep awake at night and grind for his exams. Coffee does keep him awake: the caffein attends to that; but it is at the expense of his nervous system. The harmful effects of tea are due to an alkaloid of a similar nature to the one in coffee. Here the effects are usually less marked, because the amount of alkaloid present in the ordinary cup of tea is less than in one of coffee. Cocoa and chocolate are less harmful than either tea or coffee, and they have the positive virtue of containing appreciable quantities of fat and carbohydrate; this is particularly true of chocolate.

Restrictions are galling to the average individual. Campaigns in favor of prohibition and against smoking have made him regard the social reformer

with a good deal of scorn, not unmixed with suspicion and hatred. We, personally, are in favor of freedom as against restriction, except in so far as it can be conclusively proved that restriction works for the benefit of the community as a whole. We are convinced, not from the vaporings of prohibitionists, but from studies made by physiologists, that alcohol drinking ought to be discouraged, not because the consumption of small quantities does harm, but because it so often leads to excessive drinking. A somewhat similar line of reasoning may be applied to smoking, and to tea and coffee drinking, but with less force, because the effects are not so obvious, nor is the scientific evidence so conclusive. However, when we think of man's lot in this world, how miserable it usually is, how hopeless and aimless it often seems, how the few fight the many and the many fight themselves, how the memory of a Napoleon who slays is kept green, and that of a Pasteur who heals is growing dim, then we are tempted to exclaim, "Drink and smoke —and eat, for the pleasures of life are few enough."

"Although it [alcohol] appears to be a stimulant," writes Bayliss, the eminent English physiologist, "the impression is due to an incorrect interpretation of the effects observed. It is really a narcotic. One of the most striking facts with regard to the activities of the highest parts of the

brain is the great predominance of the inhibitory mechanisms, by which the bringing into play of inappropriate movements or sensations is kept in check. Now, these mechanisms themselves are extraordinarily susceptible of being abolished by extraneous influence of various kinds. One of the most powerful of these influences is alcohol. When, therefore, greater liveliness is experienced under its action, it is because alcohol paralyzes the inhibitory mechanism and not because it excites activity by a true stimulating action. . . . After even small quantities [of alcohol are taken], the ability to add figures correctly is decreased, although the subject believes that he is doing it unusually well. Moreover, the effects last for as long as twelve hours or more. Another false idea is that alcohol warms. This is due to the fact that it dilates the blood vessels of the skin; and since the feeling of warmth arises from the skin, if this is warm, the mistaken impression is given that the body is warm. In point of fact, the general temperature is lowered, owing to the increased loss from the skin." [4]

[4] Monsieur Bordet recently proposed that the French Academy of Medicine should pass a resolution condemning categorically the sale of alcoholics. The resolution was passed unanimously. We quote these lines from the proposed resolution:

"At the present time, when, under the domination of interests that are quite evidently commercial, a very active campaign is being waged against all forms of legislation looking toward the suppression of alcoholism, the Academy of Medicine regards it as its duty to emphasize anew the necessity of strictly prohibitive

Mineral waters. In this section on beverages a word may be added on the general subject of mineral waters. These are waters that contain certain gases or salts to which they owe their peculiar properties. They are found naturally, but some are also artificially prepared. We have the French Lick Springs, rich in sulphuretted hydrogen; the Hot Springs in Virginia, containing various sulphates; the Spa Springs in Belgium, with their iron constituents; the Mineral Springs of Yellowstone Park, which are radio-active; and so on. To what extent those constituents in mineral waters which give them their distinguishing properties are responsible for "cures," is a subject very much open to debate. It is hardly likely that sulphuretted

measures. Alcohol is a poison. The only thing that, strictly speaking, can be alleged in excuse of its use is that, like other poisons, the smaller the dose the less dangerous it is, and that we can, therefore, without our health suffering gravely, tolerate a very moderate consumption of beer and wine; that is, diluted alcohol. If the time is not opportune to prohibit the use of beer and wine (which has never been planned as yet), provided these beverages do not contain a higher percentage of alcohol than the law might reasonably establish, at least distilled alcohol should be absolutely prohibited, since it is a veritable social scourge and a formidable factor in physical and moral decadence, as well as in poverty and crime. The relationships between alcoholism, on the one hand, and mental troubles and criminality on the other, are too well attested by demonstrations that we see all about us and by indisputable statistics to require further argumentation. The academy holds that existing legislation should be modified by suppressing the unfortunate provision which takes all the force out of the law; namely, the clause that authorizes the sale of distilled beverages in quantities of two liters as a minimum. The prohibition of distilled alcohol should be absolute and complete."

hydrogen contributes to cures; those who have worked with it in the laboratory will be of a diametrically opposite opinion. Nor is it likely that the sulphate waters, containing substances that are similar to those found in Epsom salts, do more than act as laxatives and purgatives. How very uncertain our knowledge is may be gauged from the fact that waters of widely varying compositions are recommended for some particular disease, and that often patients with obscure organic diseases are sent to water resorts. Yet there is no doubt that the health of thousands who frequent these watering places has been improved; here, as elsewhere, empiricism has led the way.

Condiments. These are the spicy substances, the judicious use of which is such an important adjunct for the chef who aspires to success. Salt and sugar are not only desirable but necessary foods. This applies with particular force to salt, for sugar, though an important carbohydrate, may be replaced by other carbohydrates, such as the starch in bread; but nothing can act as substitute for salt (sodium chloride), indispensable for the formation of the normal gastric juice and for the proper composition of body fluids. Pepper, mustard, horseradish, onion, vinegar, gherkins, anchovies, caviar, are all appetizing dishes, and, if taken in moderate quantities, are distinct aids to digestion. But what is food for one nation is not necessarily food for

another. One has but to think of the eagerness with which onions and garlic are swallowed by Spaniards and Italians, and the wry faces made by Englishmen and Americans at the mere mention of them.

References

For general references the following books may be consulted: E. H. S. Baily: *The Source, Chemistry and Use of Food Products* (P. Blakiston's Son and Co., Philadelphia); H. W. Wiley: *Foods and Their Adulterants* (P. Blakiston's Son and Co., Philadelphia); F. X. Gouroud: *What Shall I Eat?* (Rebman Co., N. Y.); H. W. Wiley: *Beverages* (P. Blakiston's Son and Co., Philadelphia); H. C. Sherman: *Food Products* (Macmillan Co., N. Y.); A. E. Leach and H. L. Winton: *Food Inspection and Analysis* (John Wiley and Sons, N. Y.); and H. S. Carter, P. E. Howe, and H. A. Mason: *Nutrition and Clinical Dietetics* (Lea and Febiger, Philadelphia), chapters 7–15. P. B. Hawk's *What We Eat and What Happens to It* (Harper Bros., N. Y.) is also of value. Bayliss in his *The Physiology of Food and Economy in Diet* has a good chapter (number 7) on alcohol.

Lafayette B. Mendel

LAFAYETTE BENEDICT MENDEL, PROFESSOR OF PHYSIOLOGICAL CHEMISTRY, YALE UNIVERSITY. HE, TOGETHER WITH DR. OSBORNE, HAS DONE MUCH TO THROW NEW LIGHT ON THE IMPORTANCE OF THE DIFFERENT PROTEINS AND ON THE FUNCTION OF VITAMINES IN NUTRITION.

CHAPTER III

WHAT TO EAT: THE PLANNING OF MEALS

With the contents of Chapter II in mind, it ought not be difficult to plan a well-balanced diet. But other difficulties arise. The planning may be excellent, but the execution poor: the cooking and seasoning may seem at fault—to some. And then again, as often happens with excellent but ignorant cooks whose charge of the kitchen is absolute, the planning may be poor, but the cooking all that an epicure can wish for. Such appetizing dishes, possibly deficient in essentials, and probably overabundant in meat, sugar, and cream, are harmful. The factor, however, that more often than any other gives rise to one-sided or undernourishing diets, is an economic one. At the present time it is certainly safe to say that a majority of mankind suffers from undernutrition, if not from positive starvation. To these unfortunates, whether Vienna professor, Oriental coolie, or Virginia miner, we can give no advice; only an unexpected improvement in the general rottenness of our social system will relieve their suffering.

It is not our intention to give elaborate menus with detailed directions. Our experience has taught us the utter valuelessness of such lists (except in the preparation of food for very large groups, as in the army, in hospitals, and in institutions of various kinds). We shall merely give lists of foods suitable for the three meals per day. We shall spread our wares on the table and allow the housewife to make her choice, which in turn will depend very largely on her own, her husband's and her children's tastes, and, more particularly, on the state of her husband's finances.

Breakfast: Fresh fruit in season; otherwise, stewed fruit. A variety of cereal (oatmeal, cream of wheat, etc.) with sugar (sparingly) and milk. Egg (preferably soft, scrambled, or poached), bread and butter, and coffee, tea, or milk (preferably).

Lunch: What is popularly, but erroneously, known as a vegetarian lunch is recommended. This might include bread and butter and milk (or cocoa containing much milk), and a salad (preferably a fruit one). During the winter months a vegetable soup may be ordered in addition. A salad, two slices of bread, a slab of butter and a glass of milk, constitute an ideal light lunch, and no other type of lunch is necessary, or, in the long run, is as wholesome.

Dinner: A variety of soup on alternate days

during the winter, to be discarded altogether during the summer months. Once or twice a week a special appetizer—oysters, for example—may precede this dish. Meat not more than twice a week. Chicken once a week. Fish twice a week, if possible. Arrange a dairy supper twice a week, when in the place of meat and fish you have a dish that includes eggs or cheese. Potatoes, boiled or baked, but not often fried, at least three times a week. Other vegetables, such as carrots, spinach, peas, beans, whenever possible. Milk and bread and butter. A light dessert. Fruit jelly (with a sip of cream, if you must) and raw fruit (for example, the peach and plum when in season) at least three times a week; pies less frequently, perhaps once a week. Avoid the rich, creamy, sugary combinations. Empty at least one glass of water at each meal, and preferably two at dinner.

The above includes essentials; we do not intend to discuss luxuries, for they are without end. Those with pockets full may fill their stomachs full, if they so choose, but the wiser plan is to adopt the habit of moderation, and the more humane plan is to distribute surplus wealth among those of us who are less fortunate—an advice which all of us preach and few, so few, of us practise.

With the fear of being misunderstood uppermost in our minds, we hasten to add a paragraph. No, we do not preach asceticism; we merely advise mod-

eration. The menus suggested may well be discarded on occasion. A public dinner, a theater party, a birthday feast, makes the dietitian forget his books on dietetics; there is no reason why his readers should be more conscientious.

References

Those who want more specific directions as to menus may consult E. V. McCollum and Nina Simmonds: *The American Home Diet* (F. C. Mathews Co., Detroit); meals for every day of the year are suggested. There are also some workable recipes towards the end of the book. M. S. Rose's *Feeding the Family* (Macmillan Co., N. Y.) is also of value.

CHAPTER IV

WHAT TO EAT: THE NURSING MOTHER

"There is good reason to believe," writes Professor McCollum, "that the common practice of deriving too large a part of the diet from meat, bread, sugar and potatoes, and breakfast cereals, is in no small measure responsible for the failure of many mothers to produce milk of satisfactory quality and quantity for the nutrition of their infants. There is no hardship in restricting the intake of meat and increasing the consumption of milk and green vegetables, and the mother who does so will greatly minimize the danger of a break in the healthy growth of her baby."

Diets, then, such as suggested in the last chapter, serve well, provided the mother never omits a quart of milk, at least two eggs, and some green vegetable in her daily food. Milk and the leafy vegetables have assumed an additional importance as the result of the more modern nutritional investigations.

With regard to quantities of food to be consumed (aside from quality), it may be stated that during

the earlier stages of pregnancy little beyond what is normally eaten need be taken, since the requirements of the embryo at this stage are practically negligible. From the fourth month on, however, liberal allowances ought to be made for the extra requirements of the fetus, and, in quantity at least, the mother's diet should be modelled more after the fashion of a blast furnace worker than of a university professor.

No less important than the food is the state of mind of the mother—a subject to which only casual reference can be made here. The girl with a college education, often highstrung, often exceedingly sensitive to her surroundings, is a poor match for the peasant woman, often strong in physique, and happily ignorant of much of the world's woes as they afflict a more sensitive soul. Observation has shown that during the late War many prospective mothers in England and France, in no financial want, and under the best of medical care, suffered only a shade less than the women of Germany and Austria, where the demon of malnutrition entered the houses of rich and poor alike. Many of the women in England and France had sufficient and good food; but the fault lay with their mental state: their nerves were shattered.

Poor food, or "nervous indigestion," reacts on the offspring. The reaction is not immediate, for the organism makes heroic attempts to produce,

and to continue to produce, milk of normal quality; the very tissues of the mother are not spared in this attempt. If malnutrition continues, however, then sooner or later milk of a poor quality is manufactured, and this reacts unfavorably on the child. These facts have been established by experiments on rats and on cows, and by extensive observations of human beings. Dr. Babcock records experiments with cows whose food was deficient in salt (the ordinary table salt). They were kept on this deficient diet from two to fifteen months. Some of the animals died; others recovered only when salt was administered. Yet until almost to the very last, the quantity of milk produced was little below normal.

Cows deliberately fed on a diet lacking in vitamine *A* produce a milk poor in this essential; and rats kept on such a diet produce young that fail to grow. The rickets, so prevalent among negro children, can be traced to the type of diet selected by their mothers. But we have merely to read our daily newspaper to realize what malnutrition over a number of years will do to entire populations, particularly to nursing mothers and their offspring. If we believe, with Lodge and Doyle, that the spirits of the departed endure, we may well wonder what thoughts run through the spirit of a Napoleon, a Metternich, or a Bismarck—the "makers of Modern Europe"—as he surveys the world of to-day—a

world that seems to be the product of Mephistos let loose.

References

E. V. McCollum's *The Newer Knowledge of Nutrition* (Macmillan Co., N. Y.), chapter 15, and H. S. Carter, *et al.: Nutrition and Clinical Dietetics* (Lea and Febiger, Philadelphia), chapter 5.

EMIL ABDERHALDEN, PROFESSOR OF PHYSIOLOGY AT THE UNIVERSITY OF HALLE. ONE OF THE LEADING PHYSIOLOGISTS OF THE PRESENT DAY.

CHAPTER V

WHAT TO EAT: INFANT FEEDING

This chapter is not written with any idea of supplanting the need of a physician; each child should be under the constant care of a doctor from birth until at least the end of the first year. What these pages attempt to do is to impart a certain amount of elementary knowledge, without which the mother flounders hopelessly just as soon as the doctor is out of sight.

In the first place, it must be pointed out that by far the best food for the infant during the first twelve months is its mother's milk. This has been emphasized often enough, but advertisements which have an insidious way of working themselves into the brain of man, often tend to modify that impression. We repeat then, mother's milk for the baby; this is our slogan.

Dr. Dietich, of Los Angeles, in a study of 1,000 cases in that city, finds that 37 per cent of the children were nursed at the breast for three months or less, and nine per cent were deprived of mother's milk within eight days of birth. This assumes

significance only when we state that 85 per cent of deaths under one year occur in the bottle-fed infant. Again we say, mother's milk for the baby.

Now as to some details:

Breast feeding. We shall omit such details as the nurse commonly gives the mother—the technic of feeding, the care of the nipples, the best way of holding the infant; all these are important enough, but a ten-minute demonstration is of more value than pages of description.

The breasts begin to secrete milk on the third or fourth day after the birth of the child. After the infant has been allowed two or three preliminary trials at the breast, it is immediately put on a three-hour schedule. Its feeding time may be 6, 9, 12, 3, 6, 9, 12. It should not be kept at the breast for more than twenty minutes, but while there, it is important that the nursing be steady and not intermittent. As an unbroken rest is of benefit to the child as well as to the mother who nurses it, the custom of omitting the night feeding altogether is gaining ground. This schedule should be rigidly adhered to. After the fifth month, the four-hour interval may be adopted (say 6, 10, 2, 6, 10). A serious disturbance in the health of the child may, of course, necessitate a modification of this schedule, but this should be left to the discretion of the doctor, and to none other.

By disturbances we mean such common occur-

rences as vomiting, gas and colic. Vomiting in small amount need cause no concern, but where this assumes proportions and continues, then something is the matter with the child. The disturbance may be due to one of a number of possible causes: the milk may be too rich in fat, or too much in quantity, or it may be a case of air-swallowing. If the last, then holding the infant upright for a minute or so often improves its condition. Where the milk is too rich in fat, a modification of the mother's diet may become necessary. If the quantity consumed is too large, the time between feedings may be shortened.

Milk too rich in fat or containing a protein that does not agree with the child, may give rise to colic, and in this event, aside from such immediate remedies as a hot application or an enema, it may be necessary to supplement the child's food with a little sterile water, or even to starve it for a day.

When we come to diarrhea we deal, as Dr. Grulee points out, not with a disease, but with a symptom. It may be due to one hundred and one things, and therefore the doctor should be called immediately. In the meantime, it is safe to give the child a dose of castor or mineral oil, to stop feeding, and to offer plenty of water.

Supplementary or mixed feeding is resorted to when the mother's milk is insufficient for the normal

development of the child. This includes a diet of mother's and then of diluted cow's milk. Often enough, with little or no justification, proprietary foods are introduced at this stage.

Whenever possible, the mother should continue to nurse her child for the first eight or nine months. Where the milk shows signs of insufficiency, properly prepared cow's milk, in quantity enough to offset such insufficiency, should be added to the child's diet. It is becoming the exception rather than the rule when the modern mother does not have to introduce bottle feeding at the end of the third month.

Artificial feeding. There is hardly a doctor who has not a pet formula of his own upon which to raise the coming generation, though he fully realizes that modifications are needed to fit individual cases. No attempt other than that of suggesting one of many formulas will be made; it will give the reader a basis, limited to be sure, for judgment.

First three months: One-half milk and one-half water, with the addition of two level tablespoonfuls of one of the common sugars (milk sugar, maltose, or cane sugar) to the 24-hour quantity. There is a wide divergency of opinion as to the advantages and disadvantages of the different sugars and here again the choice will depend upon the personal experience or predilection of the physician in charge.

From three to six months: Two-thirds milk, one-third water, and two tablespoonfuls of sugar.

From six to eight months: Three-fourths milk, one-fourth water, and two tablespoonfuls of sugar.

After eight months the formula should be changed to whole milk, only diluting somewhat in very hot weather.

The approximate weights and the quantities to be taken per 24 hours may be as follows:

Age	*Weight*	*Quantity per 24 hrs.*
Birth	7 pounds	20 ounces
One month	9 "	24 "
Two months	10 "	28 "
Three months	12 "	32 "
Six months	15 "	36 "
Eight months	17 "	30 "

To supply enough of the anti-scorbutic vitamine (the absence of which causes scurvy), orange juice should be started as early as the third month, perhaps even earlier; this and other fruit juices also act as preventives of and cures for constipation. The question of when to enlarge the diet by giving the infant food other than milk is one that must be left to the discretion of the physician. In general, it may be said that a child that does not gain satisfactorily will probably be given some cereal as early as the sixth month (sometimes—in the

form of barley water—this is added from the start). From then on, zwieback, toast, fruits, greens, and extracts of vegetables will follow. Eggs may be introduced in the ninth month. A little of the white of the soft-boiled egg is first offered; this is gradually increased, and finally the yolk is included. Vegetables, at first in the form of spinach or asparagus, may also be begun at this time; so may bread toast or hard cracker. The following month rice and potatoes may be introduced.

When one year old, the child's diet should include milk, orange juice, cereal, dry bread, beef juice (or still better, an egg), boiled rice or baked potatoes, and green vegetables. At fifteen months the ten P.M. bottle should be omitted. (Drinking from a glass should be introduced just as early as possible.) From now on, the amount of solid foods is gradually increased, and the amount of milk decreased to about 20 ounces. Until the end of the second year the variations and introductions include oatmeal, barley, chicken, mutton broth, zwieback, hominy, cornmeal, custard, corn-starch, rice pudding, junket, stewed prunes, baked apple, apple sauce, farina, cream of wheat, wheatena, butter (mixed with potato or rice), bread and butter, spinach, asparagus, squash, stewed tomatoes, stewed carrots, strained beans.

Sample diets for children from two to four years,

based on recommendations made by a committee working in conjunction with the New York Health Department, are as follows:

Breakfast, 7 A.M.: Cereal (oatmeal, hominy, rice or cornmeal), two to three good tablespoonfuls, with one even tablespoonful of sugar and two ounces of milk. Crisp toast or bread (stale), one or two slices with butter. Milk, eight ounces from cup.

Morning lunch, 10.30 A.M.: Milk, six ounces. Bread (stale), one slice.

Dinner, 1.30 P.M.: Cup of thick soup or one egg. Rice or macaroni, two tablespoonfuls, or one small baked potato. Fresh vegetable, two tablespoonfuls. Stewed fruit, three or four tablespoonfuls. Bread, one or two slices, with butter. Water.

Supper, 6 P.M.: Cereal, two or three good tablespoonfuls with sugar, and two ounces of milk. Milk, six ounces from cup. Bread and butter, one slice. Custard, junket or plain pudding, two to four tablespoonfuls.

One or two modifications may be recommended. It is perhaps best to start the breakfast with the juice of an orange, and it is probably wholly unnecessary to give a morning lunch at 10.30. If this meal is omitted, as may be done in most cases without any harm and with increased convenience to all concerned, the breakfast hour may be changed to

7.30 A.M., the dinner to 1 P.M., and the supper to 5.30 P.M. The schedule may then be mapped out as follows:

Breakfast: Orange juice; cooked fruit (if desired; cereal (covered with a little milk and sugar); soft-boiled egg; toast and butter; glass of milk.

Dinner: Soup or beef juice (in cold weather only); very little (about a tablespoonful) of meat, such as lamb chop, or white of chicken, not to be given more than twice a week; baked potato or boiled rice, with slab of butter; green vegetable; dessert or cooked rice; water; and milk, if possible.

Supper: Toasted bread, little sugar, and cup of milk, all mixed (the milk to be warmed on cold days); bread and butter, if desired. A cereal may be substituted for the toasted bread.

An excellent habit is to train the child to take two or three glasses of water during the day, preferably between meals. Exclude candy or anything else that appeals to the "sweet tooth" (an advice which the mother, no less than the child, would do well to heed).

From the age of five on, the child may be given much of what the adult gets, provided the diet includes a quart of milk a day, and fruit and vegetables in season, and provided that highly-spiced and excessively sugared foods are excluded. The recommendation made elsewhere, that the amount

of protein in the shape of meat be reduced, and in the shape of milk and its products (such as cheese) and eggs be increased, applies with particular force here.

References

[*J.A.M.A.* = *Journal of the American Medical Association.*]

L. E. Holt's book, *Food, Health and Growth* (Macmillan Co., N. Y.), is a valuable general discussion of the modern scientific principles underlying the nutrition of children. More practical and of equal value is the same author's *Diseases of Infancy and Childhood* (Appleton and Co., N. Y.). See also M. E. Bayley's *Practical Talks on the Care of Children* (E. P. Dutton and Co., N. Y.). A number of books devoted to infant feeding are those by C. G. Grulee (W. B. Saunders Co., Philadelphia), J. S. Fowler (Oxford University Press, N. Y.), L. E. Morse and F. B. Talbot (Macmillan Co., N. Y.), and R. H. Dennet (J. B. Lippincott and Co., Philadelphia). Much of practical value will be found in H. S. Carter's volume, *Nutrition and Clinical Dietetics* (Lea and Febiger, Philadelphia), chapters 16, 17, and 18; in J. H. Kellogg's *The New Dietetics* (The Modern Medicine Publishing Co., Michigan, 1921), pages 806-822; and in O. T. Osborne and Morris Fishbein's *Handbook of*

Therapy (American Medical Association, Chicago), pages 647-680 of the 1920 edition. A paper of value to practitioner and layman alike is one by Henry Dietrich on "An Analysis of a Series of Case Records Relative to Certain Phases of Breast Feeding," *J.A.M.A.*, volume 79, page 268, 1922. An account of the discussion which this paper aroused, when it was read at the St. Louis meeting of the Association is a very valuable feature of this article. The Labor Bureau in Washington publishes pamphlets dealing with the care and feeding of infants.

The student would do well to study the series of articles on the food requirements of children by Dr. Holt and Miss Fales, published in the *American Journal of Diseases of Children,* volume 21, page 1, 1921; volume 22, page 371, 1921; volume 23, page 471, 1922; volume 24, page 44, 1922; volume 24, page 311, 1922.

E. V. McCollum

ELMER VERNER McCOLLUM, PROFESSOR OF CHEMICAL HYGIENE, JOHNS HOPKINS UNIVERSITY. A LEADING AUTHORITY ON THE CHEMISTRY AND PHYSIOLOGY OF VITAMINES.

CHAPTER VI

VEGETARIANISM

Strictly speaking, the true vegetarian is he who abstains not only from eating meat, but from milk and eggs. Of true vegetarians we have few; of the pseudo-variety—those who include milk and eggs in their diet but exclude meat, there is a fair number. Still more are they who are beginning to realize that meat is not the indispensable article of food so many people were led to suppose—not, at least, if milk and eggs can be had; with the consequence that the wise ones among us, basing their belief partly on laboratory experiments, but largely on their own and their friends' experiences, do not consume more than one-half the meat their fathers did, but drink twice the amount of milk.

Hindhede, the Danish investigator, is fond of pointing to the Japanese as an example of a race who have thrived on a vegetarian diet. "The Japanese," he writes, "have been the means of furnishing us with abundant proof that a race of people can maintain themselves for over a thousand years in truly wonderful physical and mental condition on

very little protein, derived almost exclusively from vegetables." Their diet, as everybody knows, consists largely of rice, though this, as a rule, is far from being their sole food. "Vegetables and fruit are grown in abundance, and their value as a regular part of the diet is realized far more than in Europe." They are copious water drinkers, and this, combined with a small meat intake, has been advanced as one reason why rheumatism is practically an unknown disease in Japan. Yet it must not be forgotten that the Japanese are not really vegetarians at all, for many of them eat fish, milk and eggs, and, in the large cities, meat; that is to say, though the consumption of meat and milk and eggs per person is considerably smaller in Japan than in most European countries, these foods are not absolutely excluded from the diet. Hence it cannot be said that the Japanese—and this also applies to the Chinese—are vegetarians. There are not people wanting who connect the small stature of the Japanese with their peculiar diet, but of this we have no proof at all. Neither is it necessary to stress ideas encouraged even by some physiologists, that the meat eaters have produced the men with brains, whereas the vegetarians have not; whereupon it may follow that men who eat meat develop brains! This is a pretty little variation of the fable entitled "Phosphorus for the Brain."

In the past—and to a large extent in our own

day—the diet of man depended very much upon which part of our globe he happened to inhabit. The Eskimo in the Arctic still lives largely on a flesh diet: on the flesh of the seal, the walrus, the Polar bear, the reindeer, with an occasional addition of milk obtained from the last-named animal. The Eskimo lives on meat not because he likes it better than any other food, but because any other food is not to be had. Going to the other extreme, we find the people in the tropics leaning rather heavily towards a vegetarian diet—this time not because meat is so scarce, but because fruit and vegetables are so plentiful, and because "meat in hot weather does not agree with one." In between these extremes, we have the peoples in parts of Europe, Asia, and America, who partake more truly of a mixed diet.

First of all, let us take up strict vegetarianism—a diet which excludes not only meat, but milk and eggs; what are the advantages claimed for it? Its votaries claim that it not only prolongs life but helps to ward off sickness. Their pet reason for advocating it, however, is a moral one: man should not kill to eat. This, of course, cannot apply to the drinking of milk, but the enthusiasts of this school apparently wish to avoid anything of animal origin.

It may be said at once that, though it is possible, by making use of the results of many recent scien-

tific experiments, to plan a well-balanced vegetarian diet, it is not an easy task, for it requires a minute knowledge of the chemistry and physiology of foods, which is altogether beyond the reach of the average man, and it is beset with practical difficulties of a kind that are not easily overcome. As a class, vegetables and fruits are not only low in proteins, but low in proteins of high biological value. Comparatively large quantities of material have to be eaten to yield even the minimum nitrogen requirements, with the added probability that this nitrogen, in the shape of protein, is low in the biological scale—which is simply another way of saying that such proteins do not contain essential amino-acids in sufficient quantity. Experiments on animals conducted by Slonaker and McCollum have shown that a vegetarian diet, unless very carefully selected, and unless it includes leafy vegetables, is insufficient to maintain health.

In this connection, an experiment now being tried out at the Beth Israel Hospital, New York, is of interest. This institution caters largely, though not exclusively, to orthodox Jews, that is, such as observe the dietary laws. The superintendent, Mr. Frank, and the director of laboratories, Dr. Kahn, were of the opinion that if they could adopt a modified vegetarian diet—one that excluded meat but not necessarily fish—the question whether a food was kosher would not arise. The elimination of

the kosher problem would, incidentally, be the source of considerable saving to the hospital, for to keep within orthodox limits necessitates separate kitchens, preparation rooms, dish washing rooms, sculleries, etc.

The opinions of the most eminent nutritional experts in the country were sought: F. G. Benedict, of the Carnegie Nutritional Laboratory, Boston; R. H. Chittenden and L. B. Mendel, of Yale; W. J. Gies, of Columbia; Graham Lusk, of Cornell; E. V. McCollum, of Johns Hopkins; and V. C. Vaughan, of Michigan. Without a dissenting voice, these authorities agreed that the scheme was in every way feasible, and in many ways desirable. "I have not the slightest hesitation in saying," writes Professor McCollum, "that the vegetarian diet, supplemented with fairly liberal quantities of milk, is the most satisfactory type of diet that man can take." "Inasmuch," writes Professor Mendel, "as I myself lived upon a diet devoid of meat, fish and fowl for nearly a year, for purely experimental purposes, and remained in excellent health and vigor during that period, I have no fears regarding the wholesomeness of such a procedure." "I believe," is Professor Lusk's comment, "that the lacto-vegetarian diet could be installed in any hospital without detriment to the health of the patients."

Palatability, easily procured when meat is included, may be increased in a lacto-vegetarian diet

by the use of yeast extracts, such as "vegex," which has the flavoring qualities so highly prized by many. Both Drs. McCollum and Mendel concur in this.

The Frenchman, Professor Gautier, was of the opinion that "a system of modified vegetarianism should gradually eliminate the fierce and rugged elements from man's character, and fill the earth with gentle manners. It is both feasible and rational, and should appeal to and be practised and advocated by all who seek the ideal life and aim at producing a sweet-tempered, intellectual and artistic, yet vigorous, active and prolific race." Though we personally favor a lacto-vegetarian diet—a vegetarian diet, that is, which includes milk (and its products) and eggs—we cannot subscribe to the latter part of Professor Gautier's statement, for the very simple reason that there is no evidence either for or against it. We do not know to what extent our war-like propensities are activated or retarded by the food we eat. If we could ascertain such a relationship, it would be the most momentous discovery since the dawn of historic man.

References

By far the best account of the vegetarian diet, viewed in the light of modern knowledge, is that given by E. V. McCollum, in his *The Newer Knowledge of Nutrition* (Macmillan Co., N. Y.), chap-

ter 7. His articles entitled "The Vegetarian Diet in the Light of Our Present Knowledge of Nutrition" (*American Journal of Physiology,* volume 41, page 333, 1916), and "The Supplementary Dietary Relationship Between Leaf and Seed as Contrasted with Combinations of Seed with Seed" (*Journal of Biological Chemistry,* volume 30, page 13, 1917), should also be consulted. Professor McCollum is an authority internationally recognized. The article by Mr. L. J. Frank on "The Meatless Diet," *Modern Hospital,* November, 1921, is of interest. Much of M. Hindhede's book, *Protein and Nutrition* (Ewart, Seymour and Co., London), deals with this subject. Hindhede is also a recognized authority. The clinical aspects of vegetarianism are discussed by F. X. Gouraud in his volume, *What Shall I Eat?* (Rebman Co., N. Y., 1911), page 344.

CHAPTER VII

OVERWEIGHT AND UNDERWEIGHT

Overweight. We have little difficulty in picking out thin and fat people. Such selections, justified most of the time, are not always dependable; we need more exact data if we are to undertake a cure. But the word "cure" should not mislead the reader into supposing that in this chapter we shall deal with the sick person. If overweight be due to overfeeding and to too little exercise, the weight can be reduced without difficulty, and this is what we propose to indicate in this chapter. Where obesity is due to other causes—to diseases of various kinds—reduction in weight becomes a more difficult matter. But for every obese person who suffers from some chronic illness, there are ninety-nine persons who suffer from nothing more than overeating.

If you are called a fat or stout person, confirm it by consulting the table of average heights and weights given at the end of the book. The table is a guide and nothing more; it represents the average but not the ideal. For example, the average person gains appreciably even after he has reached

the age of thirty; a better standard would be one that assumes no gain in weight after that age.

Having decided that you belong to the overweight class, what is to be done? You are advised to eat less. But the advice is not complete without another recommendation: exercise more. And still another recommendation is necessary: select your food with care. A reduction in food intake should not involve going below minimal standards.

"Eat less and exercise more" is more easily said than done. And quick action is necessary, for otherwise you create a vicious circle. As you put on weight, the desire for exercise becomes less, though the desire for food does not decrease in proportion; whereupon it follows that the tendency is in the direction of an accelerated increase in weight.

Weight is best reduced by gradually decreasing the food intake and gradually increasing the amount of exercise taken, until the average weight for the particular height and age is reached; when, unless further complications arise, the amount of food taken and the exercise accomplished at this time should be continued unchanged.

Now, let us be more specific. Let us illustrate our thesis by selecting a man, age 40, height five feet nine inches, who is presumably in good health, but who has evidently been building up a "corporation," so that his weight, instead of being about 160 pounds, is 190. He is a city man. He goes to

the office in the morning not by walking but by taking the "L" or the subway. He sits in his office for three hours or so, and then goes to lunch with a business acquaintance. Smith has to show Jones, a customer, that things are done on a generous scale; whereupon soup and roast beef and a creamy dessert and coffee and cheese find their way into the stomachs of these good citizens. Then Smith goes back to his office, stays there another three hours, and hurries home via the "L" or the subway to Mrs. Smith who, of course, must provide a good dinner for her poor, overworked husband. Again there are meats and fatty dishes and creamy things. Then weary Mr. Smith smokes his pipe, and reads his paper, or he joins his next-door neighbor in a quiet game of cards, or, if he feels very virtuous, takes his family out for a drive.

You may say that this is an exaggerated picture. Well, perhaps it is, but the proposed cure can be so modified as to suit more moderate cases.

In the first place, it is highly desirable to include a three-mile walk in your daily routine just as religiously as you include shaving; only very bad weather should be allowed to interfere with such plans. A good way of doing this is to take one-half of it in the morning—walking towards your place of business—and one-half in the evening, walking towards home after the day's work, or taking a stroll —a brisk one, please—after supper. Next in order

is a simple form of exercise that is best done before your daily bath—a simple bending and stretching and breathing exercise lasting ten minutes or so. Dancing and skating in the winter, and golf, tennis, rowing, and swimming in the summer, are excellent means for the strengthening and preservation of one's physique.

So much for the exercise. Now as to food, an equally important part of the cure. We strongly advise against any fast, or even partial fast cures, unless on the express order of a physician. The men who go without lunch make up for it at supper, and the men who fast all day will lose weight, to be sure, but they may lose strength too. The much better plan is to adopt a diet less rich—one containing less fat and carbohydrate—than the food eaten up to the time of the cure.

One of the first items of his bill of fare that the corpulent individual seizes upon to throw into the discard is milk. As a matter of fact, that should be the very last to go. Aside from the fat, which need never be discarded altogether, milk contains protein of the highest biological value, indispensable mineral salts, and the three known vitamines. It acts, therefore, as a corrective for other foods which may be deficient in certain essentials. One to two glasses of milk per day (mixed with small quantities of tea, coffee, or cocoa, if preferred) should always be included.

Let us now make up a daily menu:

Breakfast: Fruit (preferably fresh rather than stewed), one egg, one slice of bread lightly buttered, a glass of milk (or the contents of a glass of milk mixed with a little coffee say, and one to two lumps of sugar).

Luncheon: Soup (in cold wéather), with one slice of bread and butter, and some form of salad; or, in the summer months, salad, unaccompanied by soup, with bread and butter. A glass of water and a glass of butter-milk should be emptied at this meal.

Dinner: Meat or fish, but no "second help" (the meat or fish to be replaced two or three times a week by a dish including cheese or eggs); one or, preferably, two vegetables; fruit, raw or stewed; water. No bread. (An apple an hour before bed-time. A glass of water before breakfast. Chew food slowly. Slow chewing, and the bulkiness of part of the food—the vegetables and fruit—will tend to create a sense of satisfaction long before the limit of digestive capacity is reached. No candies or other luxuries.)

Dr. Joslin, an eminent diabetic specialist, is authority for the statement that "diabetes is largely a penalty of obesity." "There is a widespread tendency," says an editoral in the *Journal of the American Medical Association,* "on the part of many clinicians to explain—perhaps one should say to ex-

cuse—obesity as the result of constitutional causes independent of mere overeating in ultimate analysis. Undoubtedly there are such instances, notably in connection with disorders of the endocrine organs or sex glands. Granted there is one person in a thousand, Joslin writes, who has some such inherent peculiarity of the metabolism which has led to obesity, there are 999 for whom being fat implies too much food or too little exercise or both combined." (See the *Journal of the American Medical Association,* volume 76, pages 79, 523 and 525, 1921.)

Underweight. A careful reading of the previous paragraphs ought to prepare the reader for an intelligent understanding of the subject of underweight. But care must be exercised in the application of knowledge. Whereas in overweight the motto ran, "Eat less and exercise more," in underweight we should not go to the opposite extreme and say, "Eat more and exercise less," but "Eat more *and* continue exercising." Moderate exercise, of the kind alluded to in previous paragraphs, should never be discarded (unless the case is a pathological one, which is then beyond the province of this chapter). Taking for granted that the individual is underweight (consult the table at the end of the book for confirmation of your own opinion), and that he is to exercise in the manner described under "overweight," what food ought he to select? Par-

ticularly those that are rich in fat and carbohydrate, though others, rich in protein, mineral salts, and vitamines, should not be neglected.

Breakfast: Fruit (preferably fresh rather than stewed); cereal and cream; two eggs; bread and butter; and a glass of milk (or the contents of a glass of milk mixed with a little tea, coffee or cocoa). Around 11 A.M.: An agreeable milk and egg combination (chocolate malted milk, containing a raw egg, for example).

Luncheon: Cream soup in winter (may be discarded in summer); bread and butter (generous portions of each); two types of vegetables (potatoes and carrots, for example); glass of milk; ice-cream or milk chocolate, if desired. Around 4 P.M.: Milk and egg combination.

Dinner: Meat or fish or cheese preparation (generous first and second helps); two kinds of vegetables; salad; several slices of bread and butter; milk; fruit and cream. (An apple an hour before bedtime. Water before breakfast and three or four times during the day, at and between meals. Moderate consumption of candy, such as milk chocolate, or chocolate mixed with nuts, or sugared almonds, not objectionable, but let the quality be of the finest.[1]

[1] There are persons who eat and eat and never grow fat. We cannot explain why such persons fail to gain in weight. "It is conceivable," we are told, "that persons of certain 'metabolic temperaments' fail to grow fat because the overfed organism in

References

A very good account is that given by Irving Fisher and E. L. Fisk in their book, *How To Live* (Funk and Wagnalls Co., N. Y., 1921), page 257. See also J. H. Kellogg's *The New Dietetics* (The Modern Medicine Publishing Co., Michigan, 1921), pages 583 and 601; and the chapter on "Overfeeding" in M. Hindhede's *Protein and Nutrition* (Ewart, Seymour and Co., London).

them wastes rather than stores the surplus of intake." This is hardly an explanation, for it is self-evident that there must be a waste somewhere if the body fails to gain in weight, even though excessive quantities of food are eaten.

CHAPTER VIII

CONSTIPATION

Constipation is the commonest digestive disturbance and among the commonest of ailments. It may be due to many causes, of which improper food is one. There are several varieties of it, from a constipation that occurs infrequently and that is often due to some particular food eaten at the time, to more chronic cases, where relief is sought in the constant use of cathartics, purgatives, and what not. We here are interested in the milder types, though much of what will be said may find general application.

First a word as to prevention. The best preventive measure is not to be found in medicines but in the food eaten. (Such factors as exercise, and the formation of regular habits, such as going to the toilet at specified times, though not discussed here, should not be overlooked.) A proper diet should include material that is not digested but that adds to the bulk of the residues in the intestine, and material that tends to wash and cleanse the digestive tube. The first is found in cellulose, the

second in water. Copious water drinking, and a diet liberal in vegetables, should insure freedom from constipation. (Notice that by "material that is not digested" we do not mean foods that are digested with difficulty, such as tough meats, unripe fruit, etc.) Foods rich in cellulose are figs, prunes, tomatoes, berries, and nuts, among fruits; oatmeal, whole wheat, graham bread, and shredded wheat, among cereals; and carrots, turnips, beets, spinach, beans, peas, celery, lettuce, cucumber, radishes, and cabbage, among vegetables. Vegetables, in fact, are all rich in cellulose.

A diet which includes foods rich in cellulose, which includes plenty of water, which includes a minimum of sweets and delicatessen, and which excludes excessive quantities of creamy productions, should lead to daily, normal evacuations. (Kellogg maintains that no man is to be considered in good health unless he has three evacuations a day. In that case the world is full of invalids, for the average man thinks himself fortunate if he evacuates daily. Dr. Kellogg, who is the Medical Director of the Battle Creek Sanitarium, is not to be dismissed lightly, however, even though his views may be that of an extremist. He is a very eminent authority on the entire question of constipation, and the reader would do well to consult his volume mentioned at the end of this chapter. A few of the rules he recommends for the care of

the colon may be mentioned. "Cellulose is the only element which can increase the bulk of the feces. One to two ounces of cellulose are needed daily. Bran is a form of cellulose; agar shows chemical resemblances to gums. Fasting, a scanty diet, a liquid diet, such as milk, gruels, porridges, a diet chiefly consisting of such foods as potatoes, rice, meat, eggs, tea, coffee and condiments, are constipating. Green vegetables contain much cellulose: these foods are laxative. Half the bulk of dried feces consists of food residues, the other half of germs and of poisonous matter excreted by the intestines, which should be gotten rid of as soon as possible. This is especially important in cases of colitis, since the intestinal mucous membrane is diseased, and in all cases of chronic disease, particularly in cases of auto-intoxication, Bright's disease, arteriosclerosis, disease of the liver, skin, thyroid gland, heart and lungs. Exercise promotes bowel action. Drugs of all sorts must be avoided.")

A daily evacuation, without effort, where the feces are in one coherent form, and where the disagreeable odor does not make itself too evident (the extent of this odor may be a rough gauge of intestinal putrefaction), should be the aim. Lauder Brunton, the English physician, relates how when he was Casualty Physician at St. Bartholomew's, "I must have seen 100,000 patients, reckoning that I saw each patient on an average about three times.

At first I was accustomed to ask the question, 'Are your bowels regular?' but I afterwards gave this up, because I found that it was ambiguous. One day I asked this question of a young woman, and she assured 'Yes, sir.' I then asked, 'How often are they open?' and she answered 'Once in three weeks, sir.' Her answer to my first question was perfectly correct, for her bowels were regular, but the term regularity conveyed a different meaning to her and to me." (*Disorders of Digestion,* Macmillan Co., London, 1893, page 72.)

Where, despite a careful selection of food, a daily evacuation is not obtained, resource must be had to other means. Temporary relief, if the constipation has lasted for a number of days, may be obtained by the use of an enema. Further prevention of constipation may be possible by the inclusion of bran or agar-agar in the diet, both of which are extremely rich in cellulose; or perhaps these in combination with a lubricant, such as any one of the mineral oils, Russian or otherwise. The use of these oils in preference to other laxatives and purgatives is recommended, since they pass through the digestive tract completely unaffected; neither have they any deleterious effect on the body.

The indiscriminate use of laxatives and purgatives should be discouraged, because they are of the nature of drugs, and give rise to drug-forming habits. By their constant use, the bowels become

more and more sluggish in their movements, and a constantly increasing effort is necessary to evacuate them. Only very recently, skin eruptions have been traced to the use of the now popular phenolphthalein, and an exhaustive study made by Professor Underhill, of Yale, shows that saline laxatives, such as Epsom, Glauber's and Rochelle salts, tend to draw water from the blood and thereby increase the concentration of the latter—a result which may lead to a pathological condition, as studies of pneumonia and the effects produced by poisonous gases have shown. Incidentally, these studies may lead to an explanation as to why natural waters are to be preferred to any of the common laxatives, for the former contain more water in proportion to dissolved solids than the latter, and hence do not tend to withdraw water from the blood to the same extent. If, then, a laxative is taken, let it be taken with plenty of water.

So far we have discussed the mild forms of constipation—those forms so very common, and yet so often neglected, that the system becomes hopelessly ruined. We have no intention of discussing more chronic cases; they are for the physician. He must study each individual case carefully, and adopt various procedures as occasion may arise. If, then, the mild measures advocated do not give relief, consult the doctor, and do not, in the name of everything you value, follow the advice of tonic

and pill distributors, whose crimes are not one jot less than those of diplomats who make war. We will, however, refer again to Professor Rettger's work (see also page 37), since it opens up many unlooked-for *possibilities*. Advisedly do we emphasize "possibilities," for we do not want to arouse in the heart of any suffering reader hopes which cannot be realized. We shall content ourselves by quoting a few significant sentences from his latest paper.

". . . The work of the past two years has shown conclusively that *bacillus acidophilus* can be implanted in the intestine of man almost at will, and that its colonization there may be such as to displace 80 per cent of the usual mixed flora. . . . *B. acidophilus* is, according to all available information, an organism which does not elaborate toxic or other harmful products. . . . Viable cultures of *B. acidophilus* when used in sufficient amounts and under the right conditions have important therapeutic properties. They are of particular merit in the treatment of chronic constipation and of diarrheas. . . . The fullest benefit from the acidophilus treatment can be derived only when the patient is under practically daily observation, and when thorough bacteriological examinations of the feces are made at frequent intervals. . . ." Drs. Kopeloff and Cheney, who have applied the acidophilus treatment to psychotic patients on Ward's

Island, N. Y., confirm Rettger's claims. They write, "Within the limitations of the data under consideration, it is evident that with the injection of *B. acidophilus* there is a change in the intestinal flora . . . and a relief from constipation and diarrhea." On the other hand, Drs. Bassler and Lutz affirm that *bacillus acidophilus* has "a very limited value in intestinal disorders." Their paper is in the nature of a polemic; no case reports are given.

Some physicians deny that in many cases of constipation, toxic products, giving rise to "auto-intoxication," find their way into the blood and poison the system. For example, Donaldson has conducted experiments on normal students who became constipated by deliberately refusing to respond to calls. These men manifested all the symptoms of auto-intoxication—coated tongue, foul breath, impairment of appetite, gas, mental sluggishness, depression, irritability, headache—which, however, disappeared as soon as a cleansing enema was taken. Had toxic substances been produced, these would have left their mark on the system even after constipation had been relieved. Furthermore, it was shown by experiments on dogs that when toxic substances are present in the intestine, they are absorbed. "The evidence shows that a retention with meat as part of the dietary of 55, 72 and 96 hours, respectively, is not attended by any accumulation of poisons in the blood stream. . . . These facts

lead me to consider that delay in the colon does not necessarily produce such a desperately toxic mess as some people would have us believe. . . . The 48-hour stasis, which is the average revelation of the carmin test in sanatorium guests, does not necessarily mean a subtle poisoning that calls for the application of colon massage and *bacillus acidophilus* therapy."

REFERENCES

[*J. A. M. A.* = *Journal of the American Medical Association*]

A very valuable book, containing a mass of information for the layman, is that by J. H. Kellogg: *The Itinerary of a Breakfast* (The Modern Medicine Publishing Co., Michigan). The viewpoint is avowedly that of a partisan, but a partisan, it seems to us, in a very worthy cause. Another popular but scientifically accurate account is that given by Irving Fisher and E. L. Lyman in their book, *How to Live* (Funk and Wagnalls Co., N. Y., 1921), page 60. More technical works are those by A. F. Hunt: *Constipation and Allied Intestinal Disorders* (Oxford University Press, N. Y.), and A. Lane: *Intestinal Stasis* (Oxford University Press, N. Y.). See also the papers by Samuel Ayers, Jr.: "Phenolphthalein Dermatitis," *J. A. M. A.*, volume 77, page 1722, 1921; F. P. Underhill: "The Influence of

Purgatives on Blood Concentration," *Journal of Pharmacology and Experimental Therapeutics,* volume 19, page 135, 1922; L. F. Rettger and H. A. Chaplin: "Bacillus Acidophilus and Its Therapeutic Application," *Archives of Internal Medicine,* volume 29, page 357, 1922; A. Bassler and J. R. Lutz: "Bacillus Acidophilus," *J. A. M. A.,* volume 79, page 607, 1922; N. Kopeloff and C. O. Cheney: "Studies on the Therapeutic Effect of Bacillus Acidophilus Milk and Lactose," *J. A. M. A.,* volume 79, page 609, 1922, and A. R. Donaldson: "Relation of Constipation to Intestinal Intoxication," *J. A. M. A.,* volume 78, page 884, 1922.

M Hindhede

DR. HINDHEDE IS THE LEADING DANISH INVESTIGATOR ON THE SUBJECT OF NUTRITION. HIS STUDIES ON THE PROTEIN REQUIREMENTS OF MAN HAVE BROUGHT HIM WORLD-WIDE FAME.

CHAPTER IX

DISEASES DUE TO FAULTY DIET

Since the days of Pasteur and Koch, the pioneers of our modern science of bacteriology, the word "disease" has been almost invariably associated with the word "microbe," as if diseases other than that due to bacteria were unknown. Recent clinical and laboratory studies in nutrition have made us revise this point of view. Disease is not necessarily microbic in origin. In fact, a number of the common ailments may be due to faulty diet, though these very often become complicated by a bacterial invasion of the body made possible only because of the body's decreased resistance. We do not intend to support the thesis that all common diseases are dietetic in origin; we merely wish to emphasize what, until very recently, has been quite ignored, that a number of them may have such an origin.

The newer viewpoint is largely the result of our knowledge of vitamines and the diseases engendered in their absence. Yet the effects of malnutrition, whether undernutrition or a lack of balance in the foods selected, had been noticed long before. In

fact, the development of the entire history of nutrition is intimately bound up with the question of malnutrition.

Hindhede. One of the earliest to perceive very clearly the intimate connection that exists between a faulty diet and various diseases was Hindhede, the Danish investigator. We have already (page 13) had occasion to refer to him, but his work is sufficiently important to be referred to again. His general thesis, as we have seen, is that we, the people as a whole, eat too much protein, and above all, too much protein in the shape of meat; and that we do not consume enough bread and vegetables. We have seen how the blockade during the Great War gave him an unexpected opportunity to put his theory into practice, and how sound his theory turned out to be. The criticism we made at the time was that in his earlier writings Hindhede minimized the importance of milk, and probably underestimated our need of protein. His later articles seem to show a revision in favor of milk, though he stands firm on the question of a low protein diet.

We disagree with his views on the question of a low protein diet. Anyone who has made a careful study of Osborne and Mendel's work on the amino-acids in proteins and their function in tissue building and repair, and who is familiar with Folin's work on protein metabolism, will be forced to the conclusion that a generous inclusion of protein in

the diet is advisable. Further, these studies demonstrate the wide variation that exists among proteins in their biologic value, the vegetable proteins being, as a rule, inferior to the animal proteins. But animal proteins include those found in milk and cheese and eggs, as well as those in meat; and we heartily agree with Hindhede when he advocates a decreased consumption of meat, provided at the same time we increase our consumption of dairy products. As to his advocacy of a diet including abundant vegetables (and fruit), we are in hearty agreement.

In Chapter 15 of his book, *Protein and Nutrition*, which, though published nine years ago, is well worth careful reading, we find such sub-titles as "Rich protein [meat] diet is not only useless, but probably harmful"; "It is probable that muscular strength declines on a rich protein [meat] diet"; "It is probable that a rich protein [meat] diet is the cause of many ailments." "I feel weaker," he writes, "after eating much meat. . . . If 30 to 60 grams [one to two ounces per day—a low estimate] be sufficient, is it really a matter for wonder that the powers of the body are severely taxed to cope with 120 to 200 grams? [100 grams is a liberal amount for the average person, provided it includes protein of animal as well as vegetable origin.] Protein which cannot be consumed entirely in the body leaves behind it a large proportion of incombustible waste which it is the office of the liver and the

kidneys to excrete, calling for special exertion on the part of these organs. Now, if this large amount of protein be unwanted, unnecessary, it is not a very far step to the assumption that it must be injurious, because such a considerable amount of energy must be devoted to catabolism in the cells and to the excretion of its waste products through the kidneys, energy which might otherwise be utilized to assist metabolism in the muscles; and in the consequent fatigue we have our explanation." When the liver is overtaxed, it is quite possible that ammonium compounds, which are toxic, and are decomposition products of proteins, and which normally are converted into the inocuous urea by the liver, fail to be detoxified and remain to poison the system.

The experiments of Professor Irving Fisher, of Yale, tend to support the view that toxic products are produced when meat is eaten, irrespective of how much; though, of course, the amount of these products would be proportionally increased as the consumption of meat is increased. Hindhede's view would imply that *any* type of protein, when eaten in excess, is harmful; which is probably very true, and also true of fat and carbohydrate; but it contributes little to support his thesis that meat protein is particularly harmful.

Conclusive experiments are wanting to show that meat proteins are more harmful (toxic) than other

proteins, but we can, from personal observation, apply Hindhede's remark to ourselves: "I feel weaker after eating much meat." This is the experience of a number of our acquaintances, and probably the reader can extend the circle that includes such men.

The Arabs, says Hindhede, live largely on figs, dates, some vegetables, and a little milk. Meat is rarely eaten. Their religion forbids them to drink alcoholic beverages. Despite the indescribable filth in which they live, they are far more immune to disease than are Europeans. "Diseases of nutrition," writes Dr. Auzimour, a French army officer, "are almost unknown; ulcers and cancer of the stomach are very seldom met with; and if one comes across a chance case of diarrhea, it is generally because the sufferer has been eating too many melons. Appendicitis is very rare among Arabs, and is entirely unknown among vegetarian nomads. Gout and kidney gravel are also quite unknown." A fact that should arrest attention is that when these Arabs desert their dirty villages for the towns, and there live the life of Europeans, eating the food Europeans do, they become as susceptible to disease as do the Occidentals. Such resistance cannot, therefore, be ascribed to the peculiarities of a race, or to the climate, but solely to the food they eat.

"For many years," continues Hindhede, "I have been convinced that common stomach troubles and

intestinal disorders very often arise from fermentation caused by putrefying animal protein, as these complaints disappear, like dew under the morning sun, on a low protein [meat] diet. Since my family and myself have adopted a low protein [meat] diet, we have never been troubled with these maladies—neither do we ever suffer from diarrhea. But with a return to a rich meat diet, for experimental purposes, I contract colic and diarrhea with mathematical certainty."

Hindhede cites Dr. Owen Williams' report to the Science Committee of the British Medical Association (1910) in support of the view that appendicitis is a meat-eating disease. Dr. Williams stresses three observations: first, that cases of appendicitis are very frequent in England, where meat is consumed in large quantity (this is equally true of America); secondly, that in the rural districts of Rumania, where but little meat is eaten, there is but one case of appendicitis for 22,000 sick patients, whereas the number of appendicitis cases in towns is increased a hundred-fold; thirdly, that the disease is rarely met with in China (the Chinese, like the Japanese, are largely vegetarian eaters). "Of 169 physicians practising in China, only 49 had ever encountered the complaint. In the General Hospital in Hong-Kong, among 2,140 patients, there was not one case of appendicitis; while in the Shanghai Hospital, which is used by Europeans, there

were 21 cases among 1,205 patients." Evidence of this kind can be multiplied, for it has been the experience of many European physicians who have been brought in touch with the Oriental races. While wishing to avoid dogmatic statements, it may be said, in the light of some evidence, that appendicitis seems to be most prevalent among the meat eating nations.[1]

Hindhede's other claim, that much meat eating gives rise to gout, can be said to be true only in so far as overeating, accompanied by little exercise, is a predisposing factor. The argument, long favored, that meat is rich in purine bodies, which may give rise to an excessive amount of uric acid, which in turn is associated with the disease, helps Hindhede little, since many vegetable foods, such as beans, oatmeal, asparagus, tea and coffee, are also very rich in purines. Gout is another disease of which we have still to learn the cause.

While the data at hand are insufficient to attribute specific diseases to meat eating, indirect evidence is not wanting for the statement that amounts such as are ordinarily consumed even by many workmen in European and American cities, and certainly by the middle and upper classes, are harmful to the system. The reader has but to think

[1] It seems but just to add that many very reputable physicians are decidedly opposed to this view. The problem is not one that lends itself to an easy solution.

of the farm life in summer, with its milk, eggs and vegetables, with meat, in the shape of chicken, perhaps once a week, and how much better he thrives on this diet than on the one he is accustomed to in the city. Of course rest and the country air are important contributory factors, but to what extent food itself may serve as a factor can only be determined if the experiment of living for a year on a diet which includes meat not more than once a week, and which substitutes for meat, milk, eggs, and cheese, is carried out.

We are nct unmindful of some dietitians who attribute brain development and energy formation to meat eating. One of them declares that "the more energetic races of the world have been meat eaters." This writer evidently wishes his reader to look first eastward, and then to the West. "In India and China," this writer may be supposed to say, "you see obvious examples of inferior races; but when you turn to the West, to England, France, Germany, and America, there you find the flower of civilization. The reason is obvious: the Indians and Chinese eat little meat, but the Europeans and Americans consume large quantities." We are not familiar with any statistical study that correlates the mental and physical growth of a race with the amount of meat consumed by it; such a study, if at all possible, may prove fruitful of result; but when we think of the glories of ancient China and India,

and of the glory that once was Greece and Rome, these representing both vegetarian and meat eating races, we doubt very much whether a chapter on meat can find an appropriate place in current systems of philosophy and psychology. Whatever evidence we have tends to show that all races are fond of meat, once they have tasted it (we recommend to the reader Lamb's inimitable essay on the roast pig), and the amount consumed is directly proportional to the state of prosperity of the race. We refuse, however, in this book at least, to be dragged into discussions dealing with economics, and possibly esthetics.

McCarrison. An even more convincing advocate of the thesis that faulty diet leads to disease is Robert McCarrison, an English physician stationed in India. Like Hindhede, he urges a greater consumption of vegetable foods, though his chief cry is raised not so much against the eating of meat as against food that has been "preserved, purified, polished, pickled, canned, extracted, distilled, concentrated, heated, dried, frozen, thawed, stored," and what not; in short, he favors the "natural foods." He, like Hindhede, is of the opinion that many of our gastro-intestinal disorders have a dietary origin, and the evidence he marshals in support of his theory has made many converts. (It should be said at this point that McCarrison's studies of "deficiency" diseases bear an intimate

relation to many vitamine studies, and to these we shall refer later.)

"My own experience," writes McCarrison, "provides an example of a race unsurpassed in perfection of physique and in freedom from disease in general, whose sole food consists to this day of grains, vegetables and fruits, with a certain amount of milk and butter, and goat's meat only on feast days. I refer to the people of the state of Hunza, situated in the extreme northernmost point of India. So limited is the land available for cultivation that they can keep little livestock other than goats, which browse on the hills, while the food supply is so restricted that the people, as a rule, do not keep dogs. They have in addition to grains—wheat, barley and maize—an abundant crop of apricots. These they dry in the sun and use very largely in the food."

McCarrison has spent some nine years among these people. The men have a magnificent physique; they live to a ridiculously old age, and are astoundingly fertile. It seems that this combination of fertility and longevity is the one great source of worry to them. One humane chieftain suggested to the doctor that instead of bringing the sick back to health again, he concentrate his attention on the construction of a lethal chamber with the aid of which it would be possible to get rid of those too old to be of use to the state! With another of these

tribes it was the custom, until quite recently, for the eldest son to put his two aged parents in a basket, carry them to the top of a hill, and then hurl to destruction the basket with its contents. We are told that this custom has been abolished "under the protective influence of British rule."

"During the period of my association with these people," writes McCarrison elsewhere, "I never saw a case of asthenic dyspepsia, of gastric or duodenal ulcer, of appendicitis, of mucous colitis (a disease involving the membrane of the colon), or of cancer, although my operating list averaged 400 major operations a year. While I cannot aver that all these maladies were quite unknown, I have the strongest reason for the assertion that they were remarkably infrequent. The occasions on which my attention was directed to the abdominal viscera (the interior of the abdomen, containing the organs of digestion) of these people were of the rarest. . . . Among these people the 'abdomen oversensitive' to nerve impressions, to fatigue, anxiety or cold was unknown. Their consciousness of the existence of this part of the anatomy was, as a rule, related solely to the sensation of hunger. Indeed, their buoyant abdominal health has, since my return to the West, provided a remarkable contrast with the dyspeptic and colonic lamentations of our highly civilized communities.

"Searching for an explanation of this difference

in incidence of gastro-intestinal disease in the two peoples, I find it in the main in four circumstances: 1. Infants are reared as Nature intended them to be reared—at the breast. If this source of nourishment fails, they die; at least they are spared the future gastro-intestinal miseries which so often have their origin in the first bottle. 2. The people live on the unsophisticated foods of nature: milk, eggs, grains, fruits and vegetables. I don't suppose that one in every ten thousand of them has ever seen a tinned salmon, a chocolate or a patent infant food, nor that as much sugar is imported to their country in a year as is used in a moderately sized hotel. 3. Their religion prohibits alcohol, and although they do not always lead in this respect a strictly religious life, nevertheless they are eminently a teetotal race. 4. Their manner of life requires the vigorous exercise of the body."

Like the Arabs, the Hunzas live in the midst of anything but sanitary surroundings, and like them again, they contract gastro-intestinal disorders whenever they change to a more "civilized" diet. These facts are of the utmost importance, for they show clearly that despite unhygienic conditions, an "unsophisticated diet" keeps them remarkably free from the common ailments to which Europeans, usually of the class other than the peasant, and Americans are subject. This, of course, is no argument in favor of filth; it is, however, evidence in

support of the view that faulty diet may also be the causative factor in disease.

These practical observations of McCarrison receive still further support from some experimental work he did, employing monkeys as the subjects of the test. "Thirty-six wild monkeys were captured in the jungles of Madras and transported with the least possible delay to my laboratory in the hills at Coonor. They were in perfect health and full vigor—wild things usually are. I had in these animals perfectly normal tissues to work on: a unique opportunity to observe the first clinical and pathologic effects on normal tissues of the agent—faulty diet—with which I was working. Each of these animals was placed in a separate cage, and all were confined in the same animal room. . . . Twelve of them were fed on natural food (wheaten bread, milk, ground nuts, onion, butter, plantains—a banana-like fruit—and water), the remaining twenty-four on food deficient in some cases in vitamines as well as ill-balanced; others were fed on natural food in which the living essences had been destroyed by sterilization. Those that were naturally fed remained free from intestinal disease; those that were fed on deficient and ill-balanced food, and on sterilized food, developed, within a short time in the majority of cases, diarrhea or actual dysentery (a disease involving the inflammation of the large intestine). Here, then, is an un-

equivocal instance not only of the effect of faulty food in inducing a specific disease such as dysentery, but of the protection against it that is afforded by a natural and well-balanced food."

War experiences. At no time in the history of the human race have the effects of a faulty diet on a people been brought home to us with more force than during the late War. The blockade made food restrictions imperative in Germany and Austria not long after the outbreak of war, but the suffering, particularly among the very old and the very young, grew intense after 1917. Even now, after four years of a peace that is no peace, one has but to read the Quaker report of conditions in Austria or the Hoover report of conditions in Russia, to realize how inadequate food, or badly-balanced food, will sap the life-blood of nations.

Rubner, the eminent director of the Hygienic Institute at the University of Berlin (he has recently resigned from this position) has given us an account of conditions in Germany. For the first two years, that is from 1914-1916, a surplus food supply, combined with an ineffective blockade, made rationing unnecessary. Conditions rapidly changed for the worse from 1916 on. In the fall of 1916 the following type of diet was planned for distribution (average man per day; food in ounces): Bread, 9; potatoes, 12; butter and margarine, one-third of an ounce; meat, 1; sugar, 1; cereals, one-third of an

Casimir Funk

CASIMIR FUNK, AUTHOR OF THE NAME "VITAMINE," AND ONE OF THE LEADING INVESTIGATORS IN THE FIELD OF VITAMINE CHEMISTRY.

ounce. No milk was provided, and eggs only rarely. The total calorific value of this food amounted to 1,334, which included a little over an ounce of protein. Rubner's standard for the needs of a normal person is 2,500 calories, including three ounces of protein. The food, then, was considerably below par; and its value was further lessened by the absence of milk and any appreciable quantities of butter and eggs. "Rubner in a personal letter to me [Professor Lusk, of Cornell] states that the decline in the health of the German people was coincident with the falling off of the milk supply."

The immediate results of such undernutrition are loss of efficiency. Laborers do not work as well, and brain workers do not think as well. This effect on physical effort is a confirmation of laboratory experiments conducted by a number of investigators. For example, Dr. Benedict, of the Carnegie Nutritional Laboratory, has shown that an insufficient diet produces "feelings of general weakness and tiredness, a condition commonly expressed in college slang as lack of 'pep' or drive; weakness of the legs; and subnormal gymnasium and athletic performance." Continued undernutrition caused considerable loss of weight. Professor Rubner calculated that the average loss of weight of individuals over 25 and living in towns was in the neighborhood of 20 per cent; which, incidentally, might have been counted as a blessing by those who

were overweight but for the fact that there was not only too little but badly-balanced food. The death rate increased considerably. If the figure for the normal death rate be taken as 100, then the figures for Germany are: 1913, 100; 1914, 100; 1915, 100; 1916, 114; 1917, 132; 1918, 137. In 1917 and 1918 the deaths above the normal rate were 260,000 and and 294,000 respectively. This condition does not merely apply to a nation living under war conditions, but is in every way applicable to the very poor in all lands who suffer from undernutrition. The slums of Peking, of London, and probably of New York, can show such examples.

As the War continued and the food supply became still less adequate, extensive outbreaks of war edema (swelling) occurred. It is recorded how in Bohemia in 1917 there were 23,000 such cases, of whom over 1,000 died. In one town nine per cent of the population suffered from the disease. The belief prevails among scientists that this edema is due to a diet comparatively rich in carbohydrate and poor in protein.

Of the suffering of the children, volumes yet remain to be written. Rickets, scurvy, xerophthalmia, and what not, were rife—and still are in places. The child not under-sized and sickly-looking became the exception. We have listened to accounts by one who worked with the Quakers in Vienna that

would make even callous diplomats and vainglorious generals evince a spark of sympathy.

Drs. Gibbon and Ferguson, two English physicians, recently (1921) made a study of the diets of 49 working class families in Vienna. The average dietary contained 2,064 calories (of a badly-balanced food), whereas the normal dietary should contain—according to the Inter-Allied Scientific Food Commission—3,300 calories of a well-balanced diet. Most of the fat taken was in the form of margarine. "Relief agencies contributed about 500 calories, or about one-fourth of the daily intake. Children between two and three years were 26.5 per cent below normal average weight and 13.6 per cent under the average normal height. Rickets was found in 29 families, the calorific intake of which averaged 1,885 calories 'per man' per day, but was absent in 20 families which partook on the average of 2,325 calories 'per man.' The writers observe 'it is hopeless to expect from a population on such diets the initiative and vigor by which alone the country can be saved from ruin.'" [Quoted by Lusk.]

Infants thrived for a time. A shortage of milk forced many mothers to "suckle their offspring" who otherwise would have been bottle-fed, and it is therefore not remarkable to find that in 1917 there was actually a decrease in infant mortality.

Despite the mother's poor food, her milk continued for a time to be biologically good; her body made every sacrifice to produce a normal milk. Only long-continued malnutrition lowered the standard of production, and with it the suffering of the offspring increased.

Undernutrition gave rise not only to mental and physical inertia, to loss of weight, to rickets and to war edema, but made the people more susceptible to disease than ever before. Tuberculosis increased in alarming proportions; so did colds, which often terminated in a fatal illness; and recovery from surgical operations became more difficult. In general the average degree of resistance to disease approached more the standard of the middle-aged clerk than that of the youthful farmer.

Hindhede attributes much of the undernutrition in Central Europe to the teachings of Rubner and his school, who favor a large meat intake. "The people of Denmark," he writes, "have no cause to regret that during the war their diet consisted mostly of milk, vegetables and bran. If Central Europe had adopted a similar diet, I doubt that any one would have starved. It seems to me, however, that the German scientists, as represented by Rubner, have not learnt anything from the war. Rubner writes about the 'necessity of bringing the supply of livestock up to the pre-war basis. . . . From what I have stated it follows that meat prod-

ucts must again form an adequate proportion of our diet.' Rubner wants an abundance of meat in order that the people can be 'aufgefuettert' [fattened]. I do not agree with him. The people must first have bread, potatoes and cabbage in sufficient quantity, and then some milk. Meat is the last requirement to be met. . . ."

Rickets, xerophthalmia, beriberi, scurvy and pellagra. These diseases, with the possible exception of pellagra, are the result of dietary deficiencies. Most of them—xerophthalmia, beriberi, and scurvy—are due to the absence of certain vitamines from the diet. At one time it was supposed that rickets is a vitamine deficiency disease, but it has recently been pretty thoroughly established that its origin is a more complex one. As we have discussed these diseases elsewhere,[2] only a brief reference to them will be included here.

Rickets, a disease with which many children are afflicted, involves retarded bone calcification, the bones becoming soft and flabby. For a long time it was held that the absence of vitamine *A* (present in codliver oil, animal fats, and the leaves of plants) from a diet gives rise to the disease, but this theory must be modified in the light of the new evidence now (August, 1922) being collected. Whatever the cause, we know that codliver oil, or exposure to the

[2] *Vitamines: Essential Food Factors* (E. P. Dutton and Co., N. Y.).

sun's rays, cures rickets, and that butter fat does not. Since codliver oil and butter fat both contain vitamine *A*, it is evident that the cure cannot be due to this substance.

Xerophthalmia. The absence of vitamine *A* from the diet very often produces xerophthalmia, an eye disease. During the late war physicians noticed many such cases among children deprived of animal fats. The addition of such fats to the diet brought prompt recovery. This merely duplicates the experiences of laboratory workers who experimented with dogs and rats.

Beriberi, a disease involving nerve degeneration, is due to the absence of vitamine *B* from the diet. Nearly all natural foods contain this vitamine. Yeast is particularly rich in it. So are milk and orange juice. The cereals contain it, but only the outer layers; so that vitamine *B* is absent from patent or bleached flour, but present in whole flour. At one time the Japanese and the Filipinos suffered considerably from beriberi, due to their large consumption of polished rice.

Scurvy, the "sailor's disease," is due to a lack of *fresh* food in the diet. The absence of vitamine *C* in foods gives rise to this disease. Most fresh fruit and fresh vegetables contain this vitamine. The emphasis is advisedly put on fresh material. The orange and the tomato are particularly rich in vitamine *C*.

Pellagra, the affliction of the South, is considered by many to be a food deficiency disease, though some are still of the opinion that it is of bacteriological origin. Dr. Goldberger, an authority, is of the opinion that pellagra is the result of a lack of several factors in food—a vitamine, a protein high in the biological scale, and perhaps certain mineral salts. Within the last few days (January, 1923) an article of his has appeared in which he attributes pellagra to food deficient in appropriate amino-acids (decomposition products of proteins).

References

[*J. A. M. A.* = *Journal of the American Medical Association*]

M. Hindhede's views on the relation of diet to disease are set forth in his book, *Protein and Nutrition* (Ewart, Seymour and Co., London), particularly in chapter 15. See also his article on "The Effect of Food Restriction During War on Mortality in Copenhagen," *J. A. M. A.*, volume 74, page 381, 1920. Robert McCarrison's work is detailed in his *Studies in Deficiency Diseases* (Henry Froude and Hodder and Stoughton, London), and in an article entitled "Faulty Food in Relation to Gastro-Intestinal Disorders," *J. A. M. A.*, volume 78, page 1, 1922. See also Irving Fisher's article in the *Yale Medical Review*, March, 1907, on "The

Influence of Flesh-Eating on Endurance." An article by Graham Lusk, "The Physiological Effect of Undernutrition," *Physiological Reviews,* volume 1, page 550, 1921, contains a wealth of valuable information. See also the following: F. G. Benedict, W. R. Miles, P. Roth and H. M. Smith: "Human Vitality and Efficiency Under Prolonged Restricted Diet," Carnegie Institute of Washington, 1919, publication 280; E. A. Kohman: "The Experimental Production of Edema as Related to Protein Deficiency," *American Journal of Physiology,* volume 60, page 378, 1920; E. S. O'Keefe: "A Dietary Consideration of Eczema in Younger Children," *J. A. M. A.,* volume 78, page 483, 1922; F. G. Benedict: "The Alcohol Problem," *Science,* volume 43, page 907, 1916; and E. V. McCollum: *The Newer Knowledge of Nutrition* (Macmillan Co., N. Y., 1922), chapter 18.

Professor Lusk's article (see preceding paragraph) deals with the food situation arising from the Great War. Other articles of a similar character are M. R. Gibbon and M. I. H. Fergusen: "Nutrition in Vienna," *Lancet,* volume 200, page 474, 1921; F. Mueller and M. Rubner: "Der Einfluss der Kriegsverhältnisse auf den Gesundheitszustand im Deutschen Reich," *Münchener medizinische Wochenschrift,* 1918, Supplement to No. 8, pages 242 and 249; and T. B. Wood: *The National Food*

Supply in Peace and War (Cambridge University Press, Cambridge, England).

For an account of such diseases as beriberi, rickets, scurvy, pellagra, xerophthalmia, see Benjamin Harrow's *Vitamines: Essential Food Factors* (E. P. Dutton and Co., N. Y.).

CHAPTER X

DIET IN DIGESTIVE DISORDERS [1]

In the preceding chapter we have seen how faulty diet may give rise to various diseases, a number of them confined to the digestive tract. In this and the succeeding chapter, our task is somewhat the reverse: the organ is diseased, and the problem is to devise a diet that will prove of maximum benefit to the sufferer, and that will produce a minimum of additional injury to the organ affected. This is a task beset with no end of difficulties: it involves a knowledge such as is possessed not only by the clinical expert, but by the chemical expert, and often the combined knowledge of these two is of no avail.

In this chapter we deal with a diseased digestive tract: something is wrong with the stomach or intestine. Such a disease will immediately affect digestion (diseases in general affect it, but usually in a secondary way; see the next chapter); for

[1] In order that the reader may have a fairly clear anatomical picture of the digestive tract, it would be well for him to master the contents of the last chapter of this book before he reads this one.

Thomas B. Osborne

THOMAS BURR OSBORNE, RESEARCH CHEMIST, CONNECTICUT EXPERIMENTAL STATION. A LEADING AUTHORITY ON THE CHEMISTRY OF THE VEGETABLE PROTEINS. LARGELY RESPONSIBLE (TOGETHER WITH PROFESSOR MENDEL) FOR OUR NEWER IDEAS CONCERNING THE PHYSIOLOGICAL VALUE OF DIFFERENT PROTEINS.

remember that the function of the digestive tube is to prepare food for assimilation by the body. With a diseased digestive tube this function is impaired, and the problem of modifying the diet to meet an abnormal condition is the task of the dietitian.

It is not our intention to discuss in detail the various possible disorders of the gastro-intestinal tract; medical treatises abound that fulfil this function admirably. We shall merely touch upon some of the commoner disorders, and then only from the point of view of dietary treatment. In this field the cooperation of the physiological chemist and the clinician has been fruitful of results. The examination of stomach contents, the analysis of blood, urine, and feces, based on quantitative methods that are constantly increasing in accuracy, have been important contributory factors in the development of modern medicine.

Hyperacidity (*hyperchlorhydria*). This illustrates an excessive production of acid in the stomach. It is not a disease but a symptom, and may be due to any one of a number of causes. It may be due to an attack of "nerves," perhaps the result of much worry; or to an ulcer in the intestinal tract; or to a diseased organ other than one belonging to the digestive organs, and producing a hyperacidity in an indirect way. The problem of decreasing the amount of acid is not always an

easy one, since so much depends upon the cause of such hyperacidity. If it is of nervous origin, anything that will tend to lessen nervous agitation will help; if due to an organic lesion, with acute pain after meals, the difficulties in the way of cure are greater.

As might be anticipated, a diet poor in acids and poor in salt (sodium chloride, one of the precursors of the hydrochloric acid of the stomach) is recommended. Strongly spiced foods of all kinds are to be avoided. Foods that may be included in the patient's diet are cream or purée soups (no meat stock); fish that consist of white meat and little fat, such as cod, halibut, bass, white fish, boiled or broiled, but not fried; vegetables, except onions, cabbage or cauliflower; milk and water in moderate quantities; cream and Swiss cheese, but not those with marked odor; desserts with cream, but without rich sauces; toasted or dry bread; fresh butter; weak tea and coffee; cereals; eggs, but not fried or hard-boiled. It is best to avoid meat. A little stewed fruit may be taken, particularly when one is constipated. Alcohol acts as a stimulant, and it should be banished from the dinner table. The mildly alkaline bicarbonate of soda has been found by Pavlow, the Russian physiologist, to retard the secretion of acid, and this alkali is often used.

Hypoacidity. This is the reverse of hyperacidity.

Here we deal with a condition in which there is less acid in the stomach than is found there under more normal conditions. Sometimes it is associated with a diminished production of the stomach ferment, pepsin (achylia). Its causes are varied. The hypoacidity may be due to an inflammation of the membrane of the stomach (gastritis), resulting in an impairment of the gastric glands; or it may be due to cancer, anemia, infections, or impairment of other organs, particularly the gall-bladder. It often follows in the wake of an attack of hyperacidity, for in the latter case there is an increased and an overtaxed glandular activity, which may be followed by a decreased and subnormal activity.

The functions of hydrochloric acid are of sufficient importance to cause its lack to bring serious consequences. The acid is a disinfectant, destroying most of the bacteria that find their way into the digestive tract; hence the advice that in cases of hypoacidity all food be boiled before eaten. But the acid also regulates the opening and closing of the pylorus, the valve connecting the stomach and the small intestine, and determines the flow of pancreatic juice and bile; so that its absence, or even its presence in diminished quantity, may prove injurious to the system.

But above all it must be remembered that the pepsin of the stomach is valueless without hydrochloric acid; so that even in the presence of the

ferment, no digestion of proteins will take place unless acid is also present. This may not be so serious a matter as appears at first glance, for proteins are also decomposed in the small intestine; but of course it is best to divide the labor wherever possible.

The foods recommended in hypoacidity are largely those prohibited in hyperacidity. Little need be excluded that is included in the diet of the normal person. Acid fruits are recommended, and so are moderate quantities of stimulants and condiments, though where the stomach is inflamed these are best avoided. Any but very small quantities of fat should be excluded from the diet, since fat delays the passage of food from the stomach to the intestines.

A standard method of treatment is to recommend small quantities of hydrochloric acid, or the acid mixed with pepsin. Dr. Kellogg recommends "acidone," an acid protein, in the place of free acid. This "acidone," prepared by mixing vegetable protein with 15 per cent of "C. P." hydrochloric acid, may be conveniently taken when mixed with soup, porridge or potato.

An *ulcer* is an open sore other than a wound. Dr. Sippy, of Chicago, whose treatment of ulcers has been widely and successfully applied, is of the opinion that the hydrochloric acid,[2] which is often

[2] We here deal more particularly with the stomach ulcer.

present in excessive quantities, is one of the potent factors in retarding the rate of healing, and his treatment involves the use of alkalis in the attempt to neutralize the acidity. Of the ulcer's origin we know little. Probably a lowered resistance of a small part of the stomach membrane, with the subsequent attack upon it by hydrochloric acid, has something to do with it. The acid unquestionably plays a rôle, since ulcers never appear in the absence of acid.

The treatment is either medical, surgical, or a combination of both. If rest and the special diet do not relieve, if pain, nausea, vomiting, and perhaps hemorrhage persist, then little may remain to be tried but a surgical operation. On the other hand, many ulcers have a tendency to heal spontaneously, so that credit for the recovery cannot be wholly ascribed to the particular diet employed.

The principles employed in the dietetic treatment are complete rest in bed for from one to perhaps three months; the use of small quantities of food, so as not to strain the stomach; the inclusion of a high percentage of protein, since the latter has a tendency to combine and, therefore, partly to neutralize the acid present; and the use of alkalis, which also assist in neutralizing acidity.

Foods included are milk, cream, soft-boiled eggs, fine cereals, cream soups, vegetable purées, jellies, custards, and cream of wheat. The excessive acidity

is neutralized (in Sippy's treatment) by the use of calcined magnesia and bicarbonate of soda.

Cancer. A malignant growth of new tissue, independent of surrounding structures, which characterizes cancer, is not confined to the stomach but may be found in many parts of the body. Cancer of the uterus is the form most frequently met with, though next in frequency comes cancer of the stomach. Of a study of 30,000 cases of cancer made by one investigator, 21 per cent were shown to be due to stomach cancer.

What the cause of the disease is we do not know.[3] In this country alone more than 80,000 of the deaths that occur every year are due to cancer. The fact that negroes are more immune to it than are whites, and the further significant fact that in Japan cancer was practically an unknown disease until recently—that is, until the country had become Europeanized—has made many lean to the theory that cancer has a dietetic origin. Dr. J. H. Kellogg, who is fond of blaming meat for most of man's ills, writes, "Of many thousands of flesh abstainers with whom I have been acquainted, I have known during a period of 45 years only four cases of cancer in persons who have been for a long time flesh

[3] "Is cancer often associated with chronic gastric ulcer? From an experience of more than 1,400 gastric specimens, I can state that the association is so frequent that if I had a chronic gastric ulcer I should always consider the possibility of cancer being present." (Dr. MacCarthy of the Mayo Clinic.)

abstainers, and in one case recovery occurred without the removal of the cancerous growth. There can be no doubt that among the thousands of persons under observation who escape the disease, as I believe through flesh abstaining, there must have been a considerable number who were especially susceptible to cancer through heredity and who were able to overcome this special susceptibility by a non-flesh dietary. This conclusion seems unescapable when it is remembered that ten to fifteen per 1,000 of all persons past middle age die of cancer."

Professor Joly, a physicist of the University of Dublin, has advanced the theory that certain foods are probably sensitizers in the sense that silver salts are, and that the eating of such foods may give rise to cancer. He mentions tannin as a striking example, and supplies statistics to show that the increased consumption of tea (in which we find tannin) in England has led to an increase in the number of cancer cases.

But the mere fact that we are writing a book on foods must not give us too dietetic an outlook. Practically all the experimental work on cancer—and an enormous mass of work has been done in this field—recognizes repeated irritation as the only established factor. For example, in "tar cancer" produced in mice, only repeated applications of coal tar derivatives give rise to this disease. The irritation theory has many supporters.

The Mayo brothers, the famous surgeons, claim that 75 per cent of all cancers originate in ulcers, which, even if true, still fails to shed light on the origin of the former, since we know little more concerning the origin of the latter.

Emaciation, loss of strength, anemia, the presence of pus and blood in the empty stomach, the absence of free hydrochloric acid, the presence of lactic acid (an acid produced when milk sours), the presence of a tumor that the diagnostician can recognize, have all been noted in this disease. As for treatment, little other than surgical can be employed. Often the X-ray treatment is suggested; the results so far are encouraging, but not more than encouraging. Temporary diminution, or even disappearance of the tumor growth, is sometimes obtained, but the growth often reappears. Operations have been only moderately successful, perhaps because in many cases the patient does not become conscious of the tumor until it has already reached alarming proportions.

As to diet, little need be said. The emphasis is placed on readily digestible foods. In the advanced stage of the disease little more than milk can be tolerated. The liquid and semi-liquid foods, soups, vegetable purées, flour puddings with fruit sauces, eggs (soft-boiled), and butter are offered whenever possible.

Diarrhea. Characterized by a frequent dis-

charge of feces in a more or less liquid condition, diarrhea is a symptom rather than a disease. It may have its origin in a diseased organ of the gastro-intestinal tract, but on the other hand it is very common in many diseases, particularly in those of a bacterial origin. It may, however, be due to a food that does not agree with the individual, to eating of indigestible food, or to excitement.

The diet in diarrhea is of an astringent character. Such a diet is not always easy to discover, since so much depends upon the particular disease with which we are dealing, and much upon the idiosyncrasy of the sufferer. A good plan to adopt at the very beginning is to take a purgative, and not to eat for twelve hours or so but to drink plenty of water. As the appetite returns, one may begin with soup, cereal gruels, tea and toast, and gradually extend the list with returning health.

In chronic diarrhea Dr. Carter recommends the following foods: clear soups; white meated fish (cod, halibut, bass); chicken, lamb; soft eggs; rice, macaroni, noodles; cereals, but not oatmeal; stale bread; cream; cottage cheese; tea; diluted whiskey or brandy. Foods to be avoided are cold drinks, green vegetables, sweets, fatty foods (except a little butter), raw milk, fruits, salads, and delicatessen.

Appendicitis. This is perhaps the most popular of gastro-intestinal diseases. It represents an in-

flammation of the vermiform appendix, a pouch leading off from the cecum (the beginning of the large intestine). The appendix (from three to six inches long and three-eighths of an inch in diameter) becomes infected, due to a retention of feces. What causes feces to be retained there is not clear.

Among the symptoms are sudden and violent pains in the abdomen, fever, nausea, vomiting, constipation, and pain produced when the abdominal region is pressed. The fever symptoms are sufficiently important for Murphy, the Chicago surgeon, to state that he would not operate on a case unless he was confident that there was fever in the first 36 hours of the disease.

The surgeon's aid should be quickly sought, for he alone can cure the patient. "There would be no percentage of deaths from appendicitis if every case commencing with acute pain and developing tenderness and rigidity of the abdomen and quickening of the pulse were operated upon within twelve hours." Delay often results in an inflammation of the peritoneum, the membrane lining the abdominal wall; and therein lies the danger.

There is, therefore, little to be said about diet in this disease, beyond the advice that rest in bed and a very light diet are merely the best preliminaries to a speedy operation.

As for methods of prevention, there are still

many who claim that meat eaters are particularly susceptible to this disease (see p. 104).

Jaundice. Jaundice is not a disease but a symptom. It indicates a disturbance of bile flow. The sufferer shows a yellowness of skin, eyes, and secretions, which is due to the presence of bile pigments in the blood. Normally the bile finds its way from the gall bladder into the small intestine (see page 188). Where an obstruction arises, due perhaps to the swelling of the membrane in or near the duct (tube) which carries the bile from the bladder to the small intestine, or to a solid conglomeration of organic and inorganic material commonly known as *gall-stones,* or to a tumor, or to a diseased liver, then the bile cannot pass into the intestine but is absorbed by the blood. One of the consequences is that the stools no longer have their usual color, but are very light gray. A more serious consequence is the disturbance in fat digestion. It has been shown that a necessary step towards the proper utilization of fats is the presence of bile in the intestine; in its absence, large quantities of unchanged fat appear in the feces.

Where an operation is not imperative, the treatment suggested by the English specialist, Russell, may be followed. "The diet ought to consist of skim milk and farinaceous foods. Care ought to be taken to have the food very thoroughly mixed with the

salivary secretions so as to ensure its more easy digestion. Medicinal treatment consists in the administration of bicarbonate of soda, rhubarb and small doses of salicylate of soda. A small dose of calomel at night, followed by a small dose of an effervescent saline aperient in the morning, may be given for a few days in succession, or on alternate days. It is better so to regulate the dose that free movement is obtained without purging. The color of the motions shows when bile has begun to pass into the bowel, and as soon as this is seen the diagnosis may be regarded as confirmed."

References

[*J. A. M. A.* = *Journal of the American Medical Association.*]

Comprehensive reviews may be found in C. D. Aaron's *Diseases of the Digestive Organs* (Lea and Febiger, Philadelphia); William Russell's *The Stomach and the Abdomen* (William Wood and Co., N. Y.); M. Einhorn: *The Duodenal Tube and Its Possibilities* (W. B. Saunders Co., Philadelphia); M. Einhorn: *Diseases of the Stomach* (William Wood and Co., N. Y.); M. Einhorn: *Diseases of the Intestine* (William Wood and Co., N. Y.); P. Cohnheim: *Diseases of the Digestive Tract* (J. B. Lippincott and Co., Philadelphia); and A. E. Austen: *Diseases of the Digestive Tract* (C. V. Mosby and

Co., St. Louis). F. Billings' *Diseases of the Digestive Tract* (D. Appleton and Co., N. Y.) is a comprehensive reference book. See also William Osler's *The Principles and Practice of Medicine* (D. Appleton and Co., N. Y.), section 5, and more particularly H. S. Carter's *Nutrition and Clinical Dietetics* (Lea and Febiger, Philadelphia), chapters 21, 22, and 23, for details as to diet. The *Diet Lists* of the Presbyterian Hospital, N. Y. (W. B. Saunders and Co., Philadelphia), compiled by H. S. Carter, are also of value in this connection.

P. Moynihan, the eminent English surgeon, is the author of a volume on the duodenal ulcer (W. B. Saunders and Co., Philadelphia). At the St. Louis meeting of the American Medical Association (May, 1922), a number of papers on gastric and duodenal ulcers were presented by Drs. A. D. Bevan, B. W. Sippy, and T. R. Brown, which led to an animated discussion. These papers, as well as an account of the discussion, may be found in the *J. A. M. A.*, volume 79, pages 22, 26, 29, and 34, 1922. See also W. J. Mayo: "Progress in the Handling of Chronic Peptic Ulcer," *J. A. M. A.*, volume 79, page 19, 1922; J. S. Horsley and W. T. Vaughan: "The Surgical Treatment of Gastric and Duodenal Ulcers," *J. A. M. A.*, volume 78, page 1371, 1922; E. H. Gaither: "Interpretation of Digestive Symptomatology," *J. A. M. A.*, volume 77, page 1407, 1921.

L. D. Bulkey: *Cancer* (William Wood and Co.,

N. Y.); W. M. L. Coplin: "A Basis for the Prevention of Cancer," *J. A. M. A.*, volume 78, page 1523, 1922; J. T. Case: "Progress and Promise in the New X-ray Treatment of Cancer," *Journal of the Michigan State Medical Society*, January, 1922; J. T. Case: "The New Short Wave Length Roentgen-Ray Therapy," *J. A. M. A.*, volume 79, page 699, 1922. ("Marked progress has been achieved in producing more penetrating roentgen rays."); and the "Foreign Letters," *J. A. M. A.*, volume 78, page 1975 and 1977, 1922.

E. Owen: *Appendicitis* (William Wood and Co., N. Y.); J. B. Sutton: *Gall-Stones and Disease of the Bile Duct* (William Wood and Co., N. Y.); S. G. Grant: *Diseases of the Colon, Rectum, and Anus* (W. B. Saunders and Co., Philadelphia); S. G. Grant: *Diarrheas* (W. B. Saunders and Co., Philadelphia); C. B. Ball: *The Rectum* (Oxford University Press, N. Y.); H. D. Rolleston: *Diseases of the Liver, Gall-Bladder and Bile Duct* (Macmillan Co., N. Y.); C. H. Mayo: "The Cause and Relief of Acute Intestinal Obstruction," *J. A. M. A.*, volume 79, page 194, 1922; and E. H. Gaither: "The Value and Limitations of Roentgen-Ray Diagnosis in Digestive Disease," *J. A. M. A.*, volume 79, page 618, 1922.

CHAPTER XI

DIET IN SOME COMMON DISEASES

Fevers. As it is not our intention to discuss in detail the various infectious diseases, and as many of them require similar dietetic treatment, we shall make here a few general remarks concerning diet in fevers.

Fevers are accompanied by an increase in body temperature; to what this is due is problematical. With a rise of temperature, the appetite becomes quickly affected: the very sight of food sickens the patient; nausea and vomiting are frequent occurrences. An initial fast of 24 to 72 hours, depending upon the disease and the state of the patient's health, is prescribed. Water, or possibly weak tea or Vichy if desired, is recommended. If, despite copious water drinking, the bowel movements become sluggish, it is well to take a purgative.

After a day or so (if the disease is not chronic, which then requires special treatment), when the temperature has perhaps decreased, and when the patient plainly evinces a desire for food, liquid food

may be offered. This may consist of milk (which is "easily digested, is a non-irritant to the stomach, does not yield an appreciable bulk of unabsorbed material, and is rarely subjected to putrefactive changes within the intestine"), or milk and barley water (if milk curds in the stomach are formed), and possibly beef juice and broths. With evidence of progress, we pass on to semi-solid foods, such as gruels (boiled for a long time), junket, custard, jelly, fruit and possibly ice-cream (if home-made, or if a particularly good brand is obtainable). Even when the stage of solid feeding is reached, only those foods that are easily digested and that are laxative, should be offered. Toast, crackers, eggs, chicken, fresh fish containing little fat (cod, halibut, bass) boiled or broiled, may be included. Fruit in the form of orange, stewed prunes, or grapes, may be given quite early in the course of the illness. Some doctors, particularly those on the Continent, prescribe a little alcohol in one of its several forms —brandy or champagne.

Tuberculosis, or as it is popularly known, consumption, is the "captain of the men of death." Someone has estimated that one-seventh of all deaths are due to it. It is an infectious disease caused by the *bacillus tuberculosis,* and gives rise to a wasting away of the tissues, such as the lungs. We have no specific remedy for it, despite the introduction some years ago of Koch's tuberculin

cure, and its extensive use by Trudeau.[1] What does help, and what has helped to cut the mortality in tuberculosis to one-half of its former figure, is fresh air and wholesome food. Plenty of milk (or if this cannot be taken, some form of fermented milk), eggs (soft-boiled rather than raw, which are not always easily digested), and fats in the form of cream and codliver oil, are to be given. But this fattening process must not assume alarming proportions (it seldom can, for that matter); when normal weight is reached, only so much food is eaten as will maintain this weight.

An example of one form of diet, advocated by Dr. Watson, which is high in the proteins of milk, is as follows: 7 A. M.: milk, one-half pint; 8.30 A. M.: milk, one-half pint, with casein (the chief protein of milk), one-half ounce, flavored with coffee or cocoa; gruel, made with milk and flavored with cream; 11 A. M.: soup thickened with one-quarter pound raw scraped beef, or soup thickened with an egg; 1 P. M.: chicken essence or veal jelly strengthened with casein, one-half ounce, and milk, one-half pint; or raw meat minced, one-quarter pound, with milk; or raw meat rissoles, with milk, or raw meat sandwiches with milk; 3 P. M.: milk with egg or thin

[1] Some doctors are of the opinion that tuberculin is valuable. "Tuberculin has a specific stimulating effect on tuberculosis tissue, and helps to lay down scar tissue. The reason it is not used more extensively is that it is not studied enough." (Dr. F. M. Pottenger)

custard; 5 P. M.: milk tea, one-half pint, with cream; 7 P. M.: meat juice, or soup with raw meat, beef extract with egg and milk forming a custard, or milk and arrowroot, with casein and cream, one-half pint; brandy may be added; 8 P. M.: an invalid food, made with milk, one-half pint, and casein. 11 P. M.: milk and egg, or chicken broth and egg.

The criticism that may be made of this dietary is that the total amount, calculated in calories, seems large, too large; and the protein consumption, even though the proteins are mainly of the milk variety, is excessive. Perhaps a good modification would be to omit the casein from the diet, and also to omit the last feeding.

Diabetes. This is a disease that involves a disturbance of the carbohydrate metabolism: sugars are not utilized properly, due, in many cases, to a diseased pancreas.[2] Relatively large quantities of sugar, in the form of glucose, appear in the blood and in the urine.

This disease is not strictly curable, though much

[2] Within the last few months Drs. Macleod and Banting, and their associates of the University of Toronto, have reported highly encouraging results on the effect of the injection of "insulin," a concentrated extract of pancreas (sweetbread) into the system of patients suffering from diabetes. The experiments have been repeated and extended in various parts of the country. Without wishing to be over-enthusiastic, it would seem as if the discovery of the Toronto physiologists will eventually be ranked with the most notable scientific achievements of the present century. (See *Transactions of the Royal Society of Canada*, volume 16, section V, page 1, 1922.)

has been accomplished by the careful regulation of the diet. In fact, progress in the treatment of diabetes has so far confined itself exclusively to changes in diet.

With the inability of the organism to handle carbohydrate food, the natural step is to omit such food from the patient's diet. When this is done, when sugars and starches are withheld, and only fat and protein offered, the remedy has still not been found, for acidosis sets in, with very serious and often fatal consequences. It is now known that the substances which, grouped together, give rise to acidosis, are derived from fat, and that acidosis is in many cases prevented when small quantities of carbohydrate are included in the diet. On the other hand, proteins themselves may be the source of sugar in the organism, for part of the protein molecule may undergo changes in the body that are similar to those undergone by carbohydrates. The situation is a difficult one; the problem of adjusting the food intake on the basis of clinical and laboratory tests is not easy. From the mass of work done by Drs. Allen, Joslin, and Newburgh, three distinguished diabetic specialists, we may summarize the present situation as follows: A preliminary fast is necessary until there is no further elimination of sugar; then the patient is put on a high fat, low protein and low carbohydrate diet, beginning with small quantities and gradually in-

creasing them until the limit of tolerance is reached, when further adjustment becomes necessary.

Joslin's résumé of Allen's treatment, as given by Dr. Carter, is as follows: Fast until sugar-free. Drink water freely and one cup of tea and one cup of coffee if desired. If sugar persists after two days of fasting, add in divided portions a little over one-half pint of meat broth. If acidosis is present, give from five to seven teaspoonfuls of alcohol daily until it disappears. (The quantitative tests for sugar and for acetone bodies—in acidosis—should be performed by carefully trained biochemists.) When the 24-hour urine is sugar-free, add, in increasing quantities, vegetables, fruit, potato, oatmeal, and bread, in the order named, unless sugar appears. When the urine has been sugar-free for two days, add two-third ounce of protein (three eggs), and thereafter one-third ounce protein daily in the form of meat until the patient is receiving about two and one-half ounces of protein. While testing the protein tolerance, a small quantity of fat is included in the eggs and meat. After the protein intake reaches about two and one-half ounces, and the limits of tolerance (as measured in the sugar output of the urine) have not been overstepped, add about one ounce of fat daily until the patient ceases to lose weight. The return of sugar demands fasting for 24 hours, or until the urine is sugar-free. The diet preceding the appearance of

sugar is then resumed (except that the carbohydrate must not exceed one-half the former tolerance) until the urine has been sugar-free for two weeks, and it should not then be increased more than one-sixth of an ounce per week.

It need hardly be added that we are not advising sufferers to discard their physicians and to treat themselves according to the directions here outlined. Far from it. The sooner the patient places himself in the hands of a competent physician the better.

In conclusion, one point is worthy of mention: statistics show that fat people are more apt to suffer from diabetes than thin people. "Diabetes is a penalty of obesity" is now becoming a favorite expression. Dr. Joslin writes: "Mr. Mead, of the Lincoln National Life Insurance, finds that the frequency of constitutional diseases in general increases as age advances, and particularly as obesity advances; but diabetes is an exception to the rule: its incidence increases with age only with the fat, while in the thin it remains constant throughout life." Here is another weighty reason for retaining one's weight within the average limits.[3]

[3] In previous pages we have noted how certain Oriental races are comparatively free from a number of diseases that afflict Occidentals. In this connection, statistics collected by Dr. F. L. Hoffman relative to deaths from diabetes are of interest. The average diabetes death rate for the United States is 16.4 per 100,000, as compared to 11.8 for England and Wales. The larger figure for America is due, in part, to the larger Jewish population. For New York City the figure is 19.8; for Berlin, 17.9; for

Gout, "the rich man's disease," which is attended by acute pains in the joints, is attributed to overeating and to too good living. Chemical studies of the blood and urine have shown that in attacks of gout a very considerable excess of uric acid finds its way into the blood and often into the urine. The faulty metabolism of uric acid, involving its chemically allied compounds, the purines, is sometimes referred to as the cause of gout, though more proof of such a relationship would be welcome. Uric acid undoubtedly has something to do with the disease.

As in diabetes, so in gout: a revision of the diet becomes the all-important factor in attempts to cure the patient. In diabetes there is a disturbed carbohydrate metabolism; hence a restricted carbohydrate diet becomes imperative. In gout there is a disturbed uric acid metabolism; hence foods containing this substance, or rather foods containing purines which give rise to uric acid, are to be avoided as far as possible. This means an almost total abstinence from meat and fish. As the gouty patient is usually the one who eats far more than his activity calls for, his total food intake is decreased and exercise prescribed.

The modern clinical school, headed by van Noor-

Copenhagen, 17.1; for Amsterdam, 15.9; for Tokio, 4.1; for Singapore, 4.3; and for Manila, 4.5. The low figures for Tokio, Singapore and Manila, as compared to the much higher figures for New York, Berlin, and Copenhagen, are certainly striking. May these differences be traced to differences in diet?

den, has adopted a method of treatment which in principle resembles the treatment of diabetes. The patient is made to undergo a preliminary fast, and is then fed first with purine-free foods, followed by foods containing these substances in ever-increasing proportions until the retention limit is reached.

The purine-free foods are eggs, milk, white bread, butter biscuits, such cereals as hominy, rice and farina, cream, sugar, potatoes (practically purine-free), cauliflower, cabbage, lettuce, nuts, cheese, sweet cider, grape juice, and unfermented fruit juices generally.

A sample diet may consist of the following:

Breakfast: apple or banana; cream of wheat or farina; one egg; a glass of milk (warm, if desired); (white) bread and butter.

Lunch: rice with cream; cheese or soft-boiled egg; bread and butter; fruit, stewed or fresh.

Dinner: baked potato (or rice or macaroni) with butter; glass of milk; one egg; lettuce or young cabbage with dressing; string beans; bread and butter; baked apple or fresh fruit. (No "second helps," not more than one slice of bread at a meal, and very little butter. Avoid generous portions.)

It may be added that various mineral waters have been suggested as sure cures for gout. There seems to be little reason to suppose that, beyond the efficacy of copious water drinking (the water rather than the mineral salts in it being important), and

the beneficial results that are bound to follow a radical and sensible change in the patient's mode of living, these mineral waters have any specific therapeutic value. Popular spring resorts are those of Saratoga and Hot Springs in this country, Buxton and Bath in England, Aix-les-Bains in France, and Carlsbad, Homburg and Marienbad in Central Europe. Lately faddists have arisen who urge the use of radio-active waters.

Nephritis, popularly known as Bright's disease, involves an inflammation of the kidneys. Pain in the region of the loins, fever, frequent but painful urination, and the presence of albumin in the urine, are among its symptoms. This disease, like diabetes, taxes every resource of the physician. In diabetes the methods of feeding should require as little as possible the services of the liver and pancreas; in nephritis the feeding is of such a nature as to relieve the the kidneys from intensive work. This is a difficult matter.

The treatment is one of two kinds, the one being in some ways diametrically opposed to the other. The Fischer treatment depends upon experimental work performed by M. H. Fischer and his pupils, work which is of the laboratory rather than of the clinical type, in which they showed that acidosis (a decreased alkalinity of the blood—a serious matter) causes swelling and the appearance of albumin in the urine. This acidosis can be relieved by alkali

treatment. Fischer argues that nephritis shows similarities to acidosis, and that the former can best be treated by means of alkalis. He finds a mixture of salt and washing soda—the latter representing the alkali—to be better than washing soda alone, since less alkali is needed, and the body does not take kindly to large quantities of this substance. The diet consists of soft foods that include large quantities of salt. No limit is set on the liquid intake.

A treatment in many ways opposed to the Fischer one, but based more largely on clinical experience, is the following: Meat is excluded from the diet immediately following the appearance of albumin in the urine. The diet offered includes milk, thin gruels, and barley water, containing as little salt as possible. To lessen the possibilities of swelling, the water intake is limited. If the treatment has been successful, the albumin in the urine will have disappeared by the end of five to six weeks. More substantial food may now be offered. Bread, rice, and potatoes are added to the dietary. Meat is still excluded.

In cases of prolonged (chronic) nephritis, "the diet selected should be based on the excretory ability of the kidneys, the condition of the heart, the blood pressure, the state of digestion, the weight of the patient, and the physical and mental work required of him. . . . It is well for the patient to have noth-

ing but skimmed milk one day in the week. It has not been shown that fresh fish, poultry, and meat, except kidney, sweetbreads, liver, and shad roe (rich in purines) are any more harmful to the nephritic patient than are the vegetable proteins such as are found in nuts, peas, beans and oatmeal, though some patients may tolerate these better." (Osborne)

Arteriosclerosis, or hardening of the arteries, due to their inflammation, is believed to arise from much the same causes as gout: from an excess of food, drink, and general good living. The diet is similar to that in gout, the emphasis being placed on little protein, and on food that is purine-free. Large quantities of food, as well as foods containing a high percentage of purines, tend to raise the blood pressure; foods which lower it are milk, fruits, vegetables and fat.

Asthma is derived from the Greek word meaning "panting," and this word describes the disease admirably. Bronchial asthma is a common form. The difficult breathing, the whistling sound, the cough, the feeling of suffocation due to the constriction of the windpipe, are well-known symptoms. The modern trend of study in this disease is to regard it, like hay-fever, as a form of anaphylaxis—a hypersensitiveness to certain proteins; and to protect against it by immunization. For example, Dr. Walker has shown how certain asthmatics who were

sensitive to proteins found in horse dandruff, could be relieved of attacks by injections of small amounts of these proteins. But so far such treatment has disposed of but few cases. The use of morphin, potassium nitrate, atropin, nitroglycerine, and adrenalin (epinephrin) is common. Asthma sufferers are often much relieved by a change of climate, particularly where the change involves settling in a mountainous region; here again we see another resemblance to hay fever.

As to diet, sweet food, fermentable vegetables (cauliflower, cabbage, or much onion or potato), alcohol, indigestible meat (goose, duck, pork) and tobacco, are to be avoided. As the attacks are most frequent at night, it is best to arrange for the principal meal at midday, and to eat little at supper time. Attacks are also accelerated by a non-laxative diet. The consumption of six to eight glasses of water per day may be of distinct help in this direction.

Eczema. This is a common form of skin disease which may be the result of improper food, of too much or too little food, or of a hypersusceptibility to certain proteins. The principle underlying the dietetic treatment is the use of food of low protein content, on the assumption that waste nitrogenous products which are retained in the system and may give rise to the disease, will be more easily eliminated. Milk, bread and butter, cereals, and fresh

vegetables, all given in moderate quantities, make up the major portion of the diet. Clinical experience teaches that fruit, unless stewed, should be withheld from the patient until he shows a marked improvement. Eczema in nursing children is best corrected by changing the diet of the mother, who is very often discovered to be eating too much and to be exercising too little. Sometimes the eczema in the child may be due to a hypersusceptibility to proteins in the mother's milk. In such a case, "the aim of treatment," writes Dr. O'Keefe, "should be to secure complete digestion of ingested protein, either by improving the digestive function, or by limiting the intake of offending proteins." Where the eczema breaks out in bottle-fed children, Holt suggests the use of a high fat, low protein diet, and if this is not successful, of a low fat, low protein diet.

Anemia, popularly regarded as a condition resulting from relatively little blood in the system. may really be due to this cause, or it may also be due to a decreased quantity of hemoglobin, or of red blood corpuscles. Whatever the cause, the oxidative power of the blood is interfered with. Imperfect nutrition, a wasting disease, or direct loss of blood, may give rise to anemia. Where the case is a fairly mild one, a careful regulation of the diet to include foods rich in iron (see under "Iron," page 21), may help, provided the patient takes exercise and gets plenty of fresh air. Meat and fish

are both rich in iron, but so are eggs, spinach, beans, wheat, oatmeal, apples and strawberries; so that no necessity arises for emphasizing a meat and fish diet.

Summary. We may try to crystallize some of the principles underlying nutrition in disease. A purely surgical case (as that of a broken limb), or a child-bed case, offer little difficulty to the dietitian. Here the appetite is very little impaired. The fact that the patient is in bed and does little exercise means that he needs less food than when active; though this does not apply to the nursing mother who, if anything, should receive more and richer food. Further, since the patient remains in bed, constipation often arises, and this must be promptly relieved. Daily evacuation of the bowels is of the utmost importance, here and elsewhere.

In diseases associated with fever, where the patient's appetite is largely impaired, the taking of a purgative, starvation for the first day or two, and copious water drinking, are standard directions. Liquid, semi-solid, and solid foods, in the order named, are gradually introduced as the patient's temperature decreases and his general condition improves.

A number of important elementary principles have to be kept in mind in the dietetic treatment of certain diseases. Where a patient has to be fattened or suffers from intestinal putrefaction, it may be

wise to increase his intake of fat and carbohydrate; on the other hand, in obesity and in acidosis (such as we find in the more advanced stages of diabetes and nephritis), a diet poor in fat, and in diabetes, a diet poor in carbohydrate, should be offered. A low protein diet should be urged in any form of intestinal disease and putrefaction, whereas a high protein diet may be suggested to convalescents, to patients suffering from fever (to some extent), and to those whose body protein is rapidly being destroyed, as in cancer and tuberculosis. Gout and nephritis suggest a diet poor in purine bodies; anemia, one rich in iron; edema (as in nephritis), one poor in salt; acidosis (in diabetes and nephritis) one rich in alkalis; and gastric ulcer, one rich in such proteins as egg white, in order that the protein may combine with the excess acid of the stomach. In the hands of the competent physician familiar with the principles of dietetics who makes an exhaustive study of his patient, whose idiosyncrasies he is familiar with, the proper adjustment of the diet to the needs of the patient is often speedily rewarded by a marked improvement in the health of the sufferer.

References

[*J. A. M. A.* = *Journal of the American Medical Association*]

Many are the books on diet and disease. See, for example, H. S. Carter, P. E. Howe and H. A. Mason: *Nutrition and Clinical Dietetics* (Lea and Febiger, Philadelphia); W. S. Hall: *Nutrition and Dietetics* (D. Appleton and Co., N. Y.); J. H. Kellogg: *The New Dietetics* (The Modern Medicine Publishing Co., Michigan); R. Hutchinson: *Food and the Principle of Dietetics* (William Wood and Co., N. Y.); C. Watson: *Food and Feeding in Health and Disease* (William Wood and Co., N. Y.); J. Friedenwald and J. Rubrah: *Diet in Health and Disease* (W. B. Saunders Co., Philadelphia); G. A. Sutherland: *A System of Diet and Dietetics* (Oxford University Press, N. Y.); and W. E. Fitch: *Dietotherapy* (D. Appleton and Co., N. Y.). The *Diet Lists* of the Presbyterian Hospital, N. Y. (W. B. Saunders Co., Philadelphia), compiled by H. S. Carter, give many practical details. A good clinical survey of many diseases is that given by W. Osler in his *Principles and Practice of Medicine* (D. Appleton and Co., N. Y.). O. T. Osborne and M. Fishbein's *Handbook of Therapy* (American Medical Association, Chicago), is also of much value.

With regard to individual diseases, an excellent

elementary manual on diabetes, written by one of our foremost authorities, is E. P. Joslin's *A Diabetic Manual* (Lea and Febiger, Philadelphia). Joslin is also the author of a more advanced treatise, published by the same firm. A few individual papers dealing with diabetes are: E. P. Joslin: "To-day's Problem in Diabetes in the Light of 930 Fatal Cases," *J. A. M. A.,* volume 78, page 1506, 1922; E. P. Joslin: "The Prevention of Diabetes Mellitus," *J. A. M. A.,* volume 76, page 523, 1921; R. M. Wilder: "Optimum Food Mixtures for Diabetic Patients," *J. A. M. A.,* volume 78, page 1878, 1922; E. E. Cornwall: "A Diebetic Dietary," *J. A. M. A.,* vol. 75, p. 1642, 1920; P. L. March, L. H. Newburgh and L. E. Holly: "The Nitrogren Requirements for Maintenance in Diabetes Mellitus," *Archives of Internal Medicinc,* volume 29, page 97, 1922; L. H. Newburgh and B. L. Marsh: "The Use of a High Fat Diet in the Treatment of Diabetes Mellitus," *Archives of Internal Medicinc,* volume 26, page 649, 1920; F. L. Hoffman: "Mortality in Diabetes," *Boston Medical and Surgical Journal,* volume 187, page 135, 1922.

A few references to other individual diseases are M. H. Fischer: *Edema* (John Wiley and Sons, N. Y.); J. Lindsay: *Gout* (Oxford University Press, N. Y.); N. B. Bardswell and J. E. Chapman: *Diet in Tubcrculosis* (Oxford University Press, N. Y.); E. S. O'Keefe: "A Dietary Consideration of Eczema in Young Children," *J. A. M. A.,* volume 78, page

483, 1922; Anon.: "Eczema in Breast-Fed Children," *J. A. M. A.*, volume 78, page 721, 1922; R. L. Cecil and N. P. Lassen: "Clinical and Bacteriological Study of 1,000 Cases of Lobar Pneumonia," *J. A. M. A.*, volume 79, page 343, 1922; H. S. Cumming: "Tuberculosis Among Ex-Service Men," *J. A. M. A.*, volume 79, page 370, 1922; J. L. Baer: "A Contribution to the Problem of Nephritis," *J. A. M. A.*, volume 79, page 622, 1922; F. M. Pottinger: "Present Status of the Treatment of Tuberculosis, *J. A. M. A.*, volume 79, page 728, 1922 ("Regardless of our lack of a specific remedy for its treatment, if the measures which have been gradually evolved during the last half century are applied during the early clinical stage, and continued for a sufficiently long time, with the hearty cooperation of the patient, nearly all patients with tuberculosis can be restored to health.") Anon: "The Immunization of Nurses to Diphtheria," *J. A. M. A.*, volume 79, page 380, 1922; and Anon: "The Function of the Bile," *J. A. M. A.* volume 79, page 382, 1922.

CHAPTER XII

THE DIGESTIVE TUBE

The life cycle. From such simple compounds as the carbon dioxide and moisture of the air, the plant builds up its complex fats and sugars. The synthesis of the still more complex proteins is made possible by the presence of nitrogen compounds in the soil. We in turn make use of these exquisitely finished products turned out in the workshops of the plant. We speak of them as foods, and we eat them, thereby being enabled to live. In the course of such utilization of food, we eliminate moisture, carbon dioxide, and nitrogenous products, which, you will recognize, are the very substances that the plant needs for its synthetic work—for the building up of carbohydrates, fats, and proteins. This give-and-take plan, this cycle of operations that connects the plant and animal kingdoms, may be spoken of as the life cycle.

The part played by the digestive tube. Life, for a low form of animal life like an amœba, is a simple process. Whatever part of its body comes in contact with food that can be utilized, will absorb the food,

and the digestion of this material will proceed in the nearest cell at hand. Waste, or non-utilizable material, is eliminated at the nearest exit—which is the nearest point at the surface. This entire process, if applied to man, would appear something like the following: a hand grasps an apple; the apple is gradually absorbed through the skin of the hand; it is digested in cells nearby; and the waste products, together with the undigested cellulose, are eliminated through the skin of the hand.

Life, unfortunately for man, is not as simple as for the amœba. Before it can enter the system the apple has to undergo certain changes. It is the function of man's digestive tube so to change the apple as to pave the way for its utilization by the body. And the evolution of man since prehistoric times has made a still more preliminary step almost indispensable: much of his food has to be cooked before it can be absorbed by the system. The cooking serves two purposes, which are related: it lessens the work of an already overtaxed digestive system, and it stimulates the activity of the digestive juices.

It is necessary at this point that we clear away a common misconception. So long as food remains in the digestive tube, whether in the mouth, in the stomach, or in the intestines, it is of no value to us as food; it only becomes of value when it is absorbed and metabolized. To make this clearer, let

us make use of an illustration. Imagine two cylinders one within the other; if the inner cylinder is made of lead, say, then we can pour water into it without the water reaching the outer vessel. If the smaller cylinder is open at both ends, water will pass in at one end and pass out at the other. If the lead cylinder is replaced by a cylinder made of more permeable material—filter paper, perhaps—then some of the water will pass through the sides of the smaller cylinder and be deposited in the larger one.

Now carry this analogy over to the structure of the body. The equivalent of the smaller cylinder is the digestive tube; that of the larger cylinder is the rest of the body. We take food into the mouth (we pour water into the smaller cylinder); the food finds its way into the stomach and then into the intestines (the water reaches the interior of the cylinder); under certain conditions food may pass right through the small and large intestines and be eliminated through the rectum unchanged (the water flows out from the bottom of the small cylinder); under more favorable conditions part of the food is absorbed through the walls of the intestine and eventually finds its way to the various cells of the body (part of the water passes through the sides of the smaller cylinder into the larger one). It is only because the walls of the digestive tube are sufficiently permeable for the passage of certain foods into the interior of the body that life is at all pos-

sible. And, indeed, the primary function of the digestive tube is to take foods that are chemically complex, that are colloidal and that are but slightly soluble in water, and convert them into products that are (chemically) relatively simple, that are crystalloidal, and that are readily soluble. The food before digestion cannot pass through the walls of the digestive tube (this does not apply to water or to mineral salts); the products formed after digestion can pass through.

This digestive process is one of self-preservation. Egg-white, a typical protein, when injected directly into the blood stream, is poisonous to the system. When, however, the egg-white is introduced into the digestive tract via the mouth, it cannot pass through the walls of the digestive tube until the juices have acted on it and have considerably simplified it (from the point of view of chemical structure). Then the products formed become permeable; and these permeable products are not only non-poisonous, but are of the utmost value in replacing waste tissues.

A view of the interior of the body. The lay reader will follow the contents of this book more intelligently if he gets a picture of the interior of the body, with particular reference to the general position of some of the more common organs.

The body (figure 1) consists of head, trunk, and limbs. The trunk is divided into the chest (thorax)

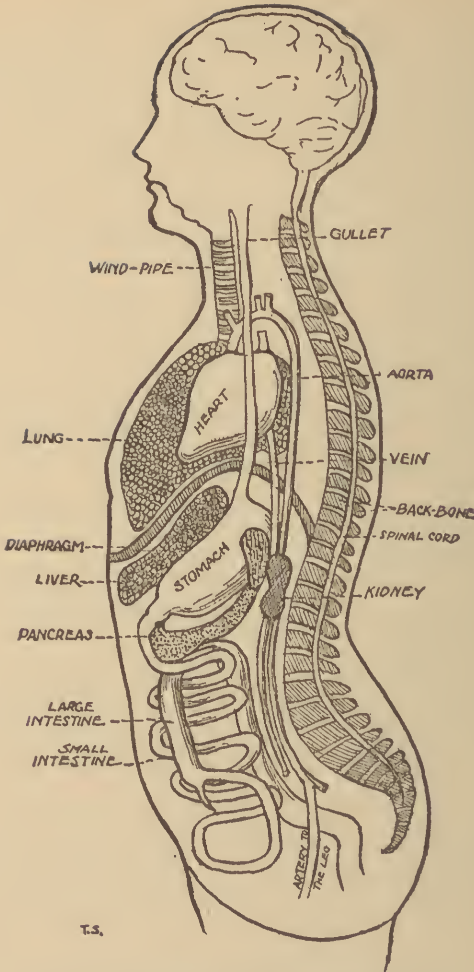


FIG. 1. GENERAL PLAN OF THE BODY.

and the belly (abdomen). A partition (called the diaphragm), stretching across the body, separates the thorax from the abdomen. Near the middle of the thorax, enclosed in a thin bag (the pericardium), is the heart. On each side of the heart is a pinkish, spongy organ, the lung. In the abdomen we find the liver with its gall bladder, situated below the diaphragm; the stomach, a little to the left of the liver and partly covered by it; the small intestine, part of which lies to the right of the stomach and close to it, and part of it occupying a large portion of the middle of the abdomen; the large intestine, a continuation of the small one; the pancreas (sweetbread), lying to the right of and below the stomach; the spleen, just below the left end of the stomach, and partly covered by the intestine; and the kidney, under the intestines, and a little above the middle of the abdomen.

The digestive tube. A tube that passes from the mouth down the neck, through the thorax, and into the upper left-hand part of the stomach, is the esophagus (gullet). This esophagus is the first portion of the digestive tube or alimentary canal. When we leave the esophagus we proceed to the stomach, then to the small intestine, then to the large intestine, and finally to the anus (figure 2).

Altogether this tube in man is about thirty feet long. To put it in a somewhat more logical way, the ratio between the length of the body and the

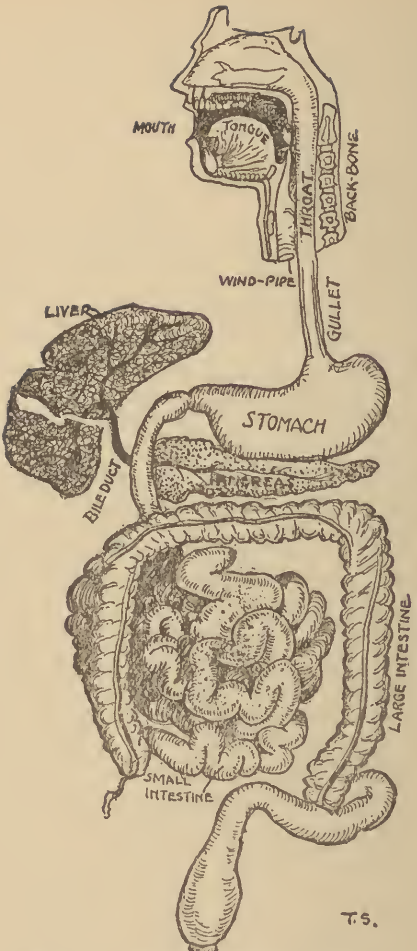


FIG. 2. THE DIGESTIVE TUBE.

length of the tube is as one is to five or six. This ratio varies considerably in different animals. In the cow the proportion is as one is to twenty, in the sheep as one is to twenty-seven, in the horse as one is to twelve, in the dog as one is to six, in the cat as one is to four. The canal, then, is much longer in herbivorous than in carnivorous animals. Grasses and herbs need more extensive preliminary treatment than flesh foods, and nature has provided for this need.

The digestive tube starts with the mouth, runs along the esophagus into the stomach, and then into the small intestine. The first portion of the small intestine, the duodenum, is some ten inches long, and is shaped in the form of a loop. It leaves the stomach at its right end, continues its path somewhat towards the right, and then travels left. The duodenum lies just below the liver. From the duodenum we pass to another small portion of the small intestine known as the jejunum, and still one further on, the ileum. Both the jejunum and ileum are more centrally situated. The length of the small intestine is about two-thirds of the entire length of the digestive tube, or twenty feet. The large intestine, a wider tube than the small one, begins at the cecum, runs up on the right side, until it almost reaches the liver (ascending colon), then across below the stomach (transverse colon), and down the left side (descending colon). From here

the continuation is by means of the rectum, a straight tube about nine inches long, which ends at the anus. Including the rectum, the large intestine is about six feet long.

You will notice in the diagram that the liver is connected by a tube (duct) with the small intestine; the pancreas (sweetbread) is connected in a similar way with the small intestine. Some of the succeeding paragraphs will make clear the importance of these organs in the general process of digestion.

We shall now discuss the various parts of the digestive tube in some detail.

The mouth. The introduction of food into the mouth, if of a solid variety, sets the teeth in motion; water and other liquids very quickly pass into the stomach. The work of the teeth is purely a mechanical one and a preparatory step in the chemical disintegration of the food material. The enzymes of the digestive juices, about which we shall have something to say presently, act so much more readily on food particles in a fine state of division than on coarser products. The chemist crystallizes this idea in a sentence when he states that chemical action is increased by increasing the surface area of the reacting bodies.

The appearance of food in the mouth brings psychic factors into play: it stimulates the activity of the digestive juices and makes the mouth water,—

a sensation that may be aroused by merely looking at or thinking about an appetizing dish. Since these digestive juices contain substances (enzymes or ferments) which act chemically on food material,

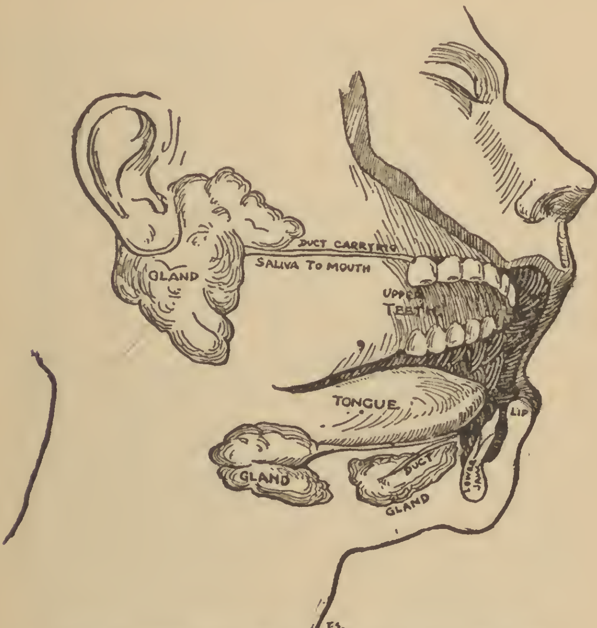


FIG. 3. THE GLANDS THAT MANUFACTURE SALIVA.

another factor, the chemical, is introduced. So that in all we have to deal with three factors, the mechanical, the psychical, and the chemical.

The mastication of the food involves not only the

teeth but the tongue and the juice obtained from the salivary glands. The lower jaw moves up and down, and to a certain extent, from side to side and from front to back. The food is kept in motion by the

FIG. 4. SEVERAL TYPES OF GLANDS.

tongue, which not only brings the food particles in intimate contact with the teeth, but also with the saliva. After a while the food, mixed with the saliva, is gathered in a bolus ready for swallowing.

But we have to stop here to investigate the origin of this fluid known as the saliva.

The saliva originates in small factories near the mouth known as glands (figure 3). Since glands and their secretions play such an important part in digestion, we must investigate these factories more closely.

Glands. The simplest type of gland consists essentially of a group of cells richly supplied with nerves and blood-vessels, and having a common exit (a tube known as a duct) through which the peculiar products which they manufacture are sent (figure 4).[1] The raw materials necessary for the manufacture of these products are obtained from the blood, the gland selecting only those substances that are necessary to form the finished material.

Saliva. The saliva is the product of three pairs of glands (see figure 3), one, the parotid, situated in front of the ears, and the other two, the submaxillary and the sublingual, stationed between the lower jaw and the floor of the mouth. Their secretions, which when mixed constitute saliva, are poured into the mouth through tubes (ducts).

Saliva, the first of the digestive juices encountered by the food, consists of more than 99 per cent

[1] Glands are known that have no ducts, but that send their products directly into the blood stream. Examples of such ductless glands (sometimes also called endocrine glands or glands of internal secretion) are the thyroid, the pituitary and the adrenals. See the author's book, *Glands in Health and Disease* (E. P. Dutton and Co., N. Y.).

of water. The remainder is made up of traces of a half a dozen different substances, the function of some of which is veiled in mystery. We here are interested in two of its constituents, the mucin and the ptyalin. Mucin is a complex substance, a combination of protein and carbohydrate, which gives the "ropy" consistency to saliva, and helps to keep the food well lubricated—a necessary step prior to swallowing the food. The ptyalin is a typical enzyme (ferment); it has the property of converting the starchy part of food into maltose, a substance belonging to the sugar group. This is a preliminary step which is necessary so that the food may ultimately be absorbed. The ptyalin is not only the most important product manufactured by the salivary glands, but it is also the product that characterizes them. The distinguishing features of the glands under discussion are that they produce enzymes which, collectively, simplify food to such an extent that it can be readily absorbed by the walls of the digestive tube and pass into the blood stream. Enzymes, therefore, are the choice products of glandular activity, and the indispensable agents in preparing food for absorption. They therefore merit further attention.

Enzymes (ferments). Everyone is familiar with alcoholic fermentation. A little yeast is put into a sugar solution and alcohol is formed. At the same time there is a frothing or boiling up of the liquid,

due to the formation of carbon dioxide (carbonic acid gas); hence the name "ferment" which is derived from the Latin *fervere,* to boil up. For a long time this process of fermentation was looked upon as a peculiar function of a living organism, such as yeast. But early in the nineties, the work of a German chemist, Edward Buchner (who, by the way, was killed in the Great War), completely upset these views. By the use of a hydraulic press, he submitted yeast cells to a pressure of several hundred atmospheres, and obtained an extract that brought about fermentation just as readily as the original yeast. This enormous pressure was of course more than enough to kill all life in the yeast; so that the conclusion was unavoidable that what produces fermentation is not the living organism at all, but a something manufactured by the living organism, which itself has no life. This something is the true ferment, or, as it is more commonly known, the enzyme (from the Greek word for yeast). These enzymes are found not only in the mouth, but in the stomach, in the pancreas, in the liver, in the intestine—in fact, in every cell of the body. There is not a reaction in any one of the multitudinous cells of the body in which enzymes are not involved. Our activity is dependent upon theirs; our very life is dependent upon their presence.

Yet, strange as it may seem, no one has so far set

eyes on an enzyme; no chemist has so far isolated a substance of this type; and in this respect, enzymes and the no less elusive vitamines have much in common. We should add that by the word isolation we mean the preparation of the enzyme in a chemically pure state; for it is not difficult to concentrate solutions containing these substances and get remarkably active products.

This at once raises the inevitable question: if you have never seen an enzyme and have never isolated it, how do you know that there is such a thing? If you have never seen a vitamine and have never isolated it, why are we wrong in regarding the vitamine as a mere illusion of the brain? These questions are perfectly natural ones, and they need to be answered in a more illuminative way than for the scientist to say, "Oh, you don't understand," or "That's beyond you." These answers encourage ignorance, widen the gap that already separates the scientist from the layman, and by no means flatter those responsible for them.

A pigeon develops polyneuritis, a disease characterized by nerve degeneration, general paralysis, and speedy death. If offered in time, a quantity of dried yeast which is not more than the hundredth of an ounce will restore the health of the bird. The recovery is little short of miraculous. Within a few hours a bird with head bent completely backwards and feet paralyzed is able to walk with head

erect. Now, the first thing that strikes the investigator is the remarkably small quantity of yeast necessary to bring about recovery. Then, when the chemist investigates what in yeast is responsible for this recovery in the bird, he finds that he can attribute it to no known constituent in the yeast. He finds by direct experiments that the proteins of yeast will not cure polyneuritis in birds; neither will the fats, nor the carbohydrates, nor the mineral salts. He has accounted for every known constituent in yeast, and not one of them, nor a combination of them, cures polyneuritis. Yet yeast taken as a whole does. What is he to make of this puzzle? By a process of elimination, he arrives at the conclusion that there must be a minute quantity of some substance in yeast which baffles all attempts to isolate it, and which is directly responsible for the cure. To this substance, and others of a somewhat similar nature, Funk has given the name "vitamine." [2]

Now let us turn our attention to the enzyme. The student in the laboratory is given a thick starch paste. He mixes a little of it with iodine solution and the mixture turns blue. He pours some of this thick starch paste onto filter paper fitted in a funnel. He next adds a little saliva to the starch, mixes gently with a stirring rod, and waits a minute or two. He again tests the starch with

[2] See the author's book, *Vitamines: Essential Food Factors* (E. P. Dutton and Co., N. Y.).

iodine; the mixture is still blue. But upon pouring some of the starch paste into a test tube, he finds that the opalescence of the solution has disappeared, and it is now quite transparent. In the meantime, the thick starch paste which refused to pass through the filter paper before the saliva had been added, now filters very easily, far more so than does saliva alone. Successive tests with iodine will bring out the fact that the blue color gives place to a reddish-blue, then to a bluish-red, then to no color at all. At the same time the starch solution, which in the beginning failed to show any reaction with Fehling's solution, now gives a bright red precipitate. (The Fehling's solution is essentially an alkaline solution of copper sulphate, and is used extensively in tests for sugars.) All these changes, as the student quickly learns, are due to the breaking down of the complex starch molecule into a simpler sugar molecule; and he is told that the substance responsible for these changes is the enzyme ptyalin present in saliva.

This ptyalin, like other enzymes, like the vitamine in yeast, like all vitamines, has not yet been isolated ("not yet" is a phrase that emphasizes the optimistic nature of the scientist). How then do we know that the ptyalin is present in the saliva? Again by a process of elimination. After we have accounted for every constituent known to be present in saliva, and have failed to bring about the change

from starch to sugar by the employment of any one constituent, or a combination of constituents, we come to the conclusion that there is something in saliva which baffles all attempts to isolate it, and which is responsible for the change of starch to sugar. This something we call an enzyme.

Boiled saliva no longer has the power of changing starch to sugar; hence we draw the conclusion that ptyalin is destroyed when boiled. Saliva cooled in a freezing mixture acts very slowly on starch; cold, therefore, retards the action of ptyalin. By pouring saliva into alcohol, a fine white powder is obtained. This powder can be redissolved in water, and shown to contain ptyalin (by its action on starch); therefore we say that ptyalin is insoluble in alcohol and soluble in water. And so we can proceed to determine the properties of ptyalin without ever having seen it, and without ever having obtained it in a chemically pure form.

We may now summarize the few preceding paragraphs by defining an enzyme as a substance which is the product of cellular activity, and which has the power of acting upon food materials, changing them, as a rule, into simpler substances.[3] One of

[3] "As a rule" is added advisedly. Enzymes are found in the animal and plant cell, particularly the latter, which are synthetic in their action; they produce complex substances from simple ones. This action is the reverse of that of enzymes found in the digestive tract, all of which are analytic, or still better hydrolytic, because water takes part in the reaction. Then there are still other enzymes which show neither synthetic nor hydrolytic

the functions of human saliva is to change the starch-containing foods into sugars, as the first of a series of steps towards the ultimate absorption of food by the system.

The process of swallowing. The food mixed with saliva, and constituting a pulp or bolus, reaches the back of the tongue, and then the opening leading into the pharynx (figure 5). The food is prevented from entering the windpipe or the nasal chamber through the coordination of the soft palate (the uvula in the diagram) and the epiglottis. From the pharynx the bolus of food passes into the esophagus (gullet), and then into the stomach. The mechanism by which the food is thrust forward when in the esophagus is known as peristaltic action. It consists essentially in a contraction of the muscular wall of the esophagus just above the bolus of food, whereby the food is pushed forward

properties, and which have to do with oxidations within the body; these are the oxidizing enzymes. This does not exhaust the list.

It would carry us too far away from our main theme to linger any further over these enzymes, but the subject is really a most fascinating one and amply repays careful investigation. We will scratch the surface in one other direction. Very small quantities of enzyme preparations—and this is true of vitamines—will bring about changes in relatively large quantities of material. This disproportion in amount between the substance acting and the substance acted upon (the substrate) is characteristic of catalytic reactions. The general subject of catalysis needs a volume all to itself, for many substances which are not enzymes are catalysts, and quite a number of essential industries are dependent upon catalytic reactions. The most recent and by far the best method for the manufacture of oil of vitriol (sulphuric acid) depends upon a catalytic reaction.

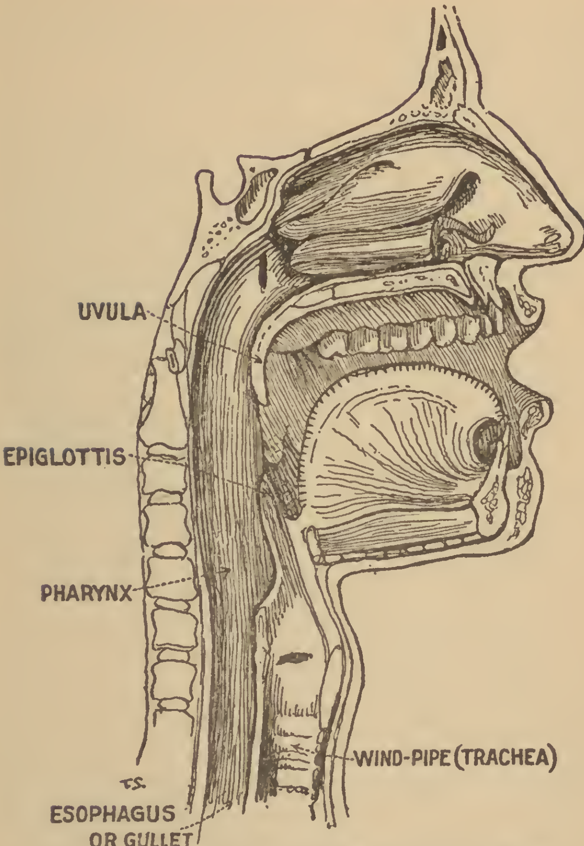


FIG. 5. A SECTION OF THE MOUTH AND NOSE.

some distance. Then there is another contraction immediately above the food mass, and the latter is once again propelled. This continues until the food

reaches the stomach.[4] It takes about five to six seconds for the food to travel from the end of the mouth to the opening of the stomach.

The stomach. The shape of this organ may be gathered from the accompanying diagram (figure 6). It is an enlarged tube, the enlargement being particularly marked on the left (cardiac) end.

FIG. 6. THE STOMACH, LIVER AND PANCREAS (SWEETBREAD).

Like the esophagus, the walls of the stomach consist of muscular tissue lined by a mucous membrane. This mucous membrane is merely a conglomeration

[4] Peristaltic action really involves two wave-like motions, a constricting wave that carries the food downward, and an inhibiting wave, in front of the constricting wave, which enables that part of the esophagus which is to receive the bolus to be relaxed.

Liquid food is somewhat differently handled. Most of it shoots right through the esophagus. After a few seconds, a peristaltic movement develops which sends any remaining liquid into the stomach.

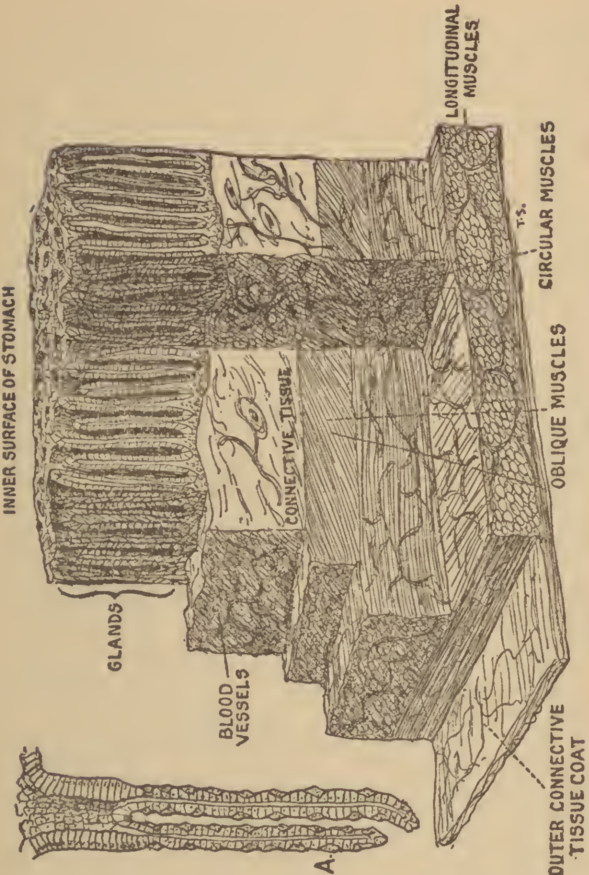


FIG. 7. A SECTION OF THE WALL OF THE STOMACH. (*A* is a gland highly magnified.)

of several layers of cells, underneath which we find connective tissue consisting of fibers and cells, and containing blood-vessels and nerves. In the

inner coat are situated the gastric glands, where gastric juice is manufactured (see figure 7).

The gastric juice. We have seen how glands situated near the mouth manufacture saliva which contains ptyalin. We have learnt how this enzyme affects starch-containing foods. We now come to the juice manufactured by glands located in the stomach wall, and known as gastric juice. Like saliva, the gastric juice consists of a disproportionate quantity of water and small quantities of a number of other substances. Among these substances we shall mention three, because of the part they play in digestion: pepsin, rennin, and hydrochloric acid. Pepsin and rennin are enzymes, like ptyalin, but unlike the latter, they have no action on starch.[5] Pepsin acts on the protein part of foods (like meat and the white of egg), and rennin (rennet) acts on milk, forming a curd (the making of cheese illustrates this operation). We find, however, that pepsin has no action on protein unless acid is present, and the hydrochloric acid serves this purpose. This substance, present in the gastric juice to the extent of four-tenths of one per cent, gives the acid properties to the liquid. Under the common name of muriatic acid, it is sold in drug

[5] An interesting controversy which still wages in the camps of the scientists is whether pepsin and rennin are two distinct enzymes, or whether they are merely two different parts of one enzyme molecule. The swing of the pendulum is slightly in favor of the former view.

stores, and, if taken in quantity, is a distinct poison. The fruits we eat do not contain hydrochloric acid; no food does. The acid is manufactured in the stomach; just how, we do not know.

Just as the function of the ptyalin of the saliva is to convert starch-containing foods into simpler products (sugars) so as to prepare the way for absorption, so the pepsin-hydrochloric acid of the gastric juice converts protein-containing foods into simpler bodies (peptones), and with the same object in view.

Recent studies have shown that for some time after the food reaches the stomach, salivary digestion proceeds. This is contrary to the opinion held for a long time, since it was supposed that the acidity of the stomach juice would be sufficient to destroy the ptyalin, on the assumption that enzymes are easily destroyed by acids. Enzymes, with the exception of pepsin, are easily destroyed by acids, and even pepsin is, if the acid is concentrated enough. Under ordinary conditions, the addition of a solution containing ptyalin to gastric juice is enough to destroy the ptyalin. But it must not be forgotten that when the food reaches the stomach it is in the form of a bolus, with some of the saliva not only outside, but inside of the mass. This protects at least some of the ptyalin from immediate attack by the acid. There is still another factor which aids, for a time, ptyalin activity in the stom-

ach. The hydrochloric acid forms a temporary union with the protein of the food, and in this combined state it is far less effective in destroying the salivary enzyme.

The food settles in the cardiac part of the stomach (see figure 6), the stomach becomes distended, and gradually the food, in the form of a semi-liquid (chyme) spreads itself over the entire surface. Wave-like motions of the stomach wall bring about thorough mixing of the food, and the peristaltic motion sends portions of it to the pyloric end of the stomach. There the valve (sphincter) opens from time to time and admits the chyme into the first portion of the small intestine (the duodenum).

While the food in the mouth stays but a minute or so, we have already seen that salivary digestion does not stop immediately after the food reaches the stomach. In fact, this digestion may proceed in the cardiac end of the stomach for half an hour or so. Then gastric activity begins, and this may last from three to four hours, at the end of which time the last traces of a meal will have left the stomach.

The presence of hydrochloric acid makes the gastric juice valuable in several ways. We have already mentioned that without acid the pepsin is powerless to digest proteins. The acid has also high antiseptic value. Harmful bacteria that lodge

in the mouth and pharynx, or that are swallowed with the food, are largely destroyed by the acid, the completeness of such destruction being largely dependent upon the state of health of the individual. Koch, the celebrated German investigator, has shown that even cholera bacilli are destroyed by the acid. On the other hand, where the acid becomes diminished in amount, that is no longer true.

To summarize the functions of the gastric juice, we may say that the pepsin, in conjunction with the hydrochloric acid, acts on proteins and simplifies them in preparation for absorption by the system, that the rennin (rennet) causes curdling of the milk protein (an operation useful enough in making cheese, but not one that is obviously necessary in the stomach of an adult person), and that the hydrochloric acid has a strong antiseptic action. Some claim that the gastric juice has some effect on fats, but if so it is extremely slight. We shall see how an enzyme developed by the pancreas decomposes fats. Neither in the mouth, nor in the stomach, nor in the intestines, do water and salts undergo any change. Chemically they are so simple that they are absorbed as such.

Digestion in the small intestine. What takes place here is a more complex affair, and it will be advisable, if the main threads of our story are not

to be lost, to present a rapid bird's-eye view of the reactions, and then proceed to discuss them in detail.

If the reader will turn again to figure 6, he will notice that not only is the stomach connected with the small intestine, but so are two other organs, the gall bladder (from the liver) and the pancreas (sweetbread). But whereas the small intestine is a logical continuation of the stomach, both forming part of the digestive tube, this is not true of the liver and the pancreas, for they are joined to the intestine by narrow tubes or ducts. These ducts, you will remember, are the exit tubes of glands; it is through them that secretions are poured. The liver and pancreas are two very large glands, the former being the largest in the body, and they pour their secretions into the intestine. The duodenum, which is the name given to this particular part of the intestine, develops a secretion all its own (the succus entericus); so that the duodenum becomes the meeting ground for three distinct secretions.

When food pours from the pyloric end of the stomach into the duodenum, juices from the three glands are soon ready to bid it welcome. This time whatever work remains to be done in order to facilitate absorption is completed. There are enzymes that complete the decomposition of proteins; there are enzymes that change remaining carbohydrates into the simplest sugars; and there

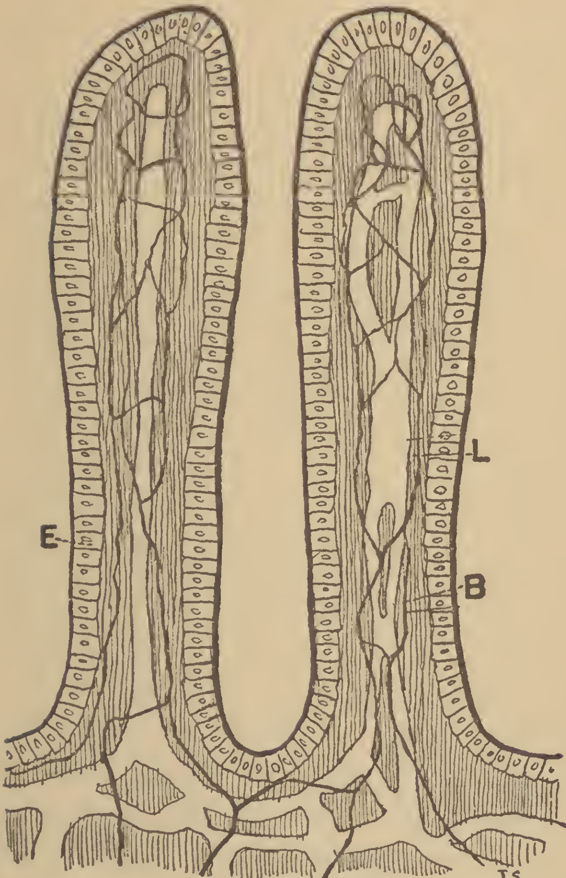


FIG. 8. TWO VILLI, HIGHLY MAGNIFIED.
E, epithelium; B, blood-vessels; L, lacteals.

is still another enzyme which, helped by the bile (the juice which originates in the liver), disintegrates fats.

The small intestine. We have had occasion to allude to the small intestine in our description of the digestive tube as a whole. It may be remembered that it is the longest part of the digestive tract, since it occupies some two-thirds of the entire length of the digestive tube. This length is of importance if we remember that practically the entire process of absorption of foodstuffs takes place through the walls of the small intestine; which means that a large surface is essential. This surface is enlarged more than four-fold by a peculiar and distinctive structure. If we examine the surface of the small intestine, we find that it is not level, like the stomach, but has finger-like projections, called villi. Each one of these, a villus, is club-shaped and covered by a lining of cells (figure 8). Under the lining we have connective tissue interspersed by blood-vessels. Through the centre of these villi pass tubes known as lacteals, through which there passes the lymph. It is through these villi that absorption of food takes place.

Like the stomach, the wall of the small intestine contains glands (glands of Lieberkühn) which manufacture juice (succus entericus) of value in digestion (figure 9). This juice contains a protein-splitting, and several sugar-splitting enzymes. It

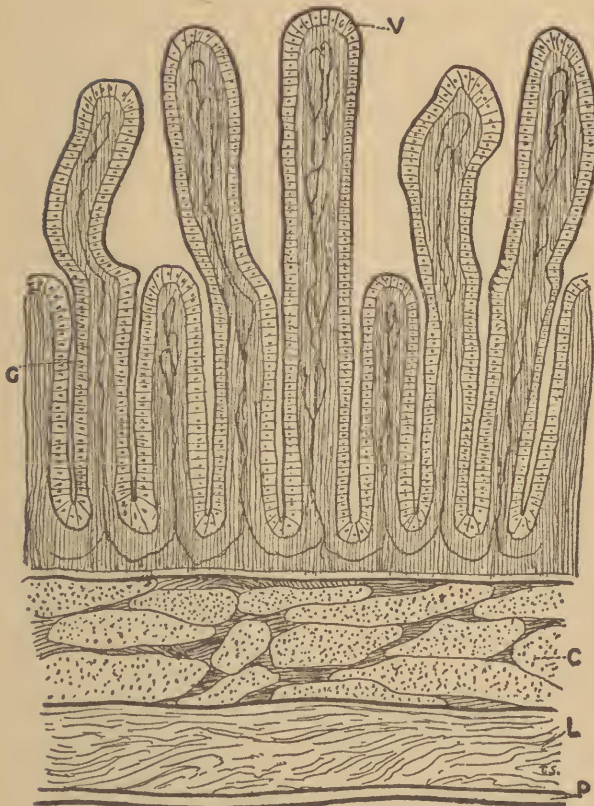


FIG. 9. STRUCTURE OF THE WALL OF THE SMALL INTESTINE.
V, villi; G, glands; C, circular muscle layer; L, longitudinal muscle layer; P, peritoneum, or coat.

also contains an enzyme (entero-kinase) which has the property of activating the enzymes of the pancreatic juice. This activation is a peculiar process,

and is by no means confined to the pancreatic juice. We find it to be true of the gastric juice, for example; the activator there is the hydrochloric acid. To express it figuratively, the process of activation consists in rousing the enzyme from its sleep and getting it to work.

The pancreas (*sweetbread*). If the reader will turn to figure 6, he will note the situation of the pancreas with reference to the other organs of the body. The entire pancreas is a gland, and, incidentally, the most important digestive gland, because it manufactures all three types of enzymes necessary for digestion: trypsin, an enzyme which acts on proteins; amylopsin, an enzyme which acts on starch-containing foods; and lipase, an enzyme which acts on fats. In each case the action is characterized by a breaking down of complex into simpler substances; and the latter, and not the former, are absorbed through the villi of the small intestine.

The three enzymes are found in the pancreatic juice, which in turn is manufactured by the pancreatic glands. The juice pours into the small intestine through a duct (figure 6).

The interesting question of what causes the flow of pancreatic juice into the intestine has been answered by two English physiologists, Bayliss and Starling, who have shown that the acid contents of

the chyme (the food leaving the stomach) release a substance (secretin) from the walls of the small intestine, which finds its way into the blood stream, and thence to the pancreas, there stimulating the flow of pancreatic juice. This messenger (or hormone) belongs to a group of substances manufactured by ductless glands; that is to say, glands which have no ducts, but which pour their secretions directly into the blood stream.[6] The glands so far discussed in this chapter—and those directly involved in the digestive process—all have ducts. A good example of a ductless gland is the thyroid, situated in the neck. The small intestine, the pancreas and the liver have glands with and without ducts. The intestinal glands with ducts develop the intestinal juice containing digestive enzymes which we have already discussed. The intestinal glands without ducts manufacture the secretin which is absorbed directly by the blood and influences a distant organ (the pancreas)—a characteristic property of ductless glands. The pancreas itself, in addition to forming pancreatic juice (in glands with ducts), forms a substance, or series of substances, in its ductless glands which regulates liver functions. It is the belief that the deteriora-

[6] See the author's book, *Glands in Health and Disease* (E. P. Dutton and Co., N. Y.).

tion of these ductless glands within the pancreas gives rise to the commonest form of diabetes.

The liver (see figure 6) is the largest gland of the body, weighing from three to four pounds. Its functions are many and diverse, and we must prevent ourselves from enlarging upon them, since many of them are not immediately concerned with the digestive process. We may, however, state that most of the food that passes through the walls of the small intestine first finds its way (via the blood) to the liver, where a sifting process is inaugurated, the carbohydrate being retained and stored as glycogen until such time as the body may wish to make use of it.

The liver glands manufacture bile which is sent by means of a duct into the small intestine. When not immediately wanted, this bile is sent through a branch duct into the gall bladder, where it is stored. This bile, though practically free from enzymes, is important in digestion, because it facilitates the breaking up of fats. Its color (from red to green to blue) is due to a mixture of pigments derived from the blood-pigment, hemoglobin.

Digestion in the small intestine. The food which enters the intestine from the stomach is met, then, by three juices: the succus entericus, representing the intestinal juice; the pancreatic juice; and the bile. The food mixes with these juices, is acted upon by them, is carried along the length of the

small intestine by means of peristaltic movements of the muscular walls of the tube, and the properly digested particles are absorbed through the villi lining the route.[7]

[7] Some readers may be interested in a tabulated summary.

Liquid	*Enzymes present*	*Action*	*Products formed*
Intestinal juice	Erepsin	On partially decomposed proteins	Amino-acids
"	Sucrase	Sucrose (cane sugar)	Glucose and fructose (simple sugars)
"	Maltase	Maltose (a sugar)	Glucose
"	Lactase	Lactose (milk sugar)	Glucose and galactose (simple sugars)
"	Entero-kinase	Activates enzymes in pancreatic juice	
Bile	None, but contains bile salts that act in conjunction with lipase		
Pancreatic juice	Trypsin	Proteins	Amino-acids
"	Lipase	Fats	Fatty acids, soaps and glycerin (simpler bodies)
"	Amylopsin	Starch (and similar substances)	Maltose (a sugar)

The large intestine (see figure 2) is a continuation of the small one, and ends in the rectum. It takes up the undigested food and carries it forward by means of peristaltic movements. Here water is largely eliminated by absorption through its walls, and the contents become more and more solid in consistency, until finally the residues are discarded in the form of feces. While we find little enzymic

To complete the matter, we may summarize salivary and gastric secretions in a similar manner:

Liquid	*Enzymes present*	*Action*	*Products formed*
Gastric juice	Pepsin	Proteins	Peptones (simpler bodies)
"	Rennin	Casein (of milk)	"Curd"
Salivary juice	Ptyalin	Starch (and similar substances)	Maltose

When all proteins are decomposed into amino-acids, when fats are decomposed into fatty acids, glycerin and soap, when starch and some of the other more complex carbohydrates are decomposed into glucose, fructose and galactose, then absorption of the products becomes possible.

A close scrutiny will reveal what appear as duplications of the digestive process. For example, we notice that starch is digested in the mouth as well as in the small intestine. It must be evident that such duplication ensures better digestion. But this explanation is not wholly satisfactory, The dog's saliva does not contain any ptyalin, and yet the healthy animal manages to dispose of its starch with the help only of the amylopsin from the pancreatic juice. Stomachs have been removed from the dog and from man, the food passing directly from the gullet into the small intestine, without any obvious ill-effects. However, this would be a poor reason for removing a stomach from a healthy person! We must view abnormalities that do not appear to harm the system as an attempt made by the body to compensate for a loss. The ultimate cost to the body of such attempts at compensation has yet to be learnt.

action in the large intestine, there is considerable bacterial activity, which in turn gives rise to some evil-smelling products. Cellulose, found so abundantly in fruits and vegetables, is perhaps the commonest form of material in the food which is not digested. Micro-organisms probably decompose small quantities of it in the large intestine, but as the body does not possess enzymes that can digest it, the greater portion passes out undecomposed. In herbivora, bacterial action is probably carried on on a much larger scale, since a considerable quantity of cellulose disappears. The laxative properties of fruits and vegetables are largely due to their content of cellulose.

What happens to the food after being absorbed through the small intestine. As our intention in this book is to confine ourselves more exclusively to digestive processes, we shall cast but a hasty glance over the processes of absorption, assimilation, and excretion. The products of carbohydrate and protein digestion are absorbed by the blood vessels in the villi of the small intestine, and those of fat digestion, by the lacteals (see figure 8). The carbohydrate products, consisting of simple sugars, find their way (via the portal vein) to the liver, where they are stored in the form of glycogen. This glycogen is used whenever the body has to expend energy. Some of the protein products (the amino-acids) are taken up by the cells of the body, and

resynthesized into tissue protein; others are decomposed by the liver and largely changed into urea, which is eliminated through the kidneys and appears in the urine. The products of fat digestion seem to be resynthesized into fat soon after absorption (just why, we do not know), sent via the lymphatic system to the thoracic duct in the neck, and thence into the general circulation, and to the adipose tissue, where the fat is stored until needed. Despite the brilliant work that has been done by many investigators in different lands, many of the details involved in the metabolic process remain a mystery. We know what we put into the mouth, and we can analyze the products eliminated in the feces, in the urine, in the sweat and from the lungs; but the various intermediate steps in the process are not well understood.

References

A book which gives the essentials of anatomy and physiology very admirably, and which is adapted to the needs of a beginner, is T. H. Huxley's *Lessons in Elementary Physiology* (Macmillan Co., N. Y.). M. Foster's *Elementary Physiology* (Macmillan Co., N. Y.) is very much the same type of book. Other good elementary works, in which an account of the digestive system is included, are: R. Burton-Opitz: *An Elementary Manual of Physiology* (W.

B. Saunders Co., Philadelphia); P. G. Stiles: *Nutritional Physiology* (W. B. Saunders Co., Philadelphia); P. G. Stiles: *Human Physiology* (W. B. Saunders Co., Philadelphia); R. C. Pearce and J. J. R. Macleod: *Fundamentals of Human Physiology* (C. V. Mosby Co., St. Louis); W. D. Halliburton: *Essentials of Chemical Physiology* (Longmans, Green and Co., N. Y.); W. M. Bayliss: *An Introduction to General Physiology* (Longmans, Green and Co., N. Y.); A. Davison: *The Human Body and Health* (American Book Co., N. Y.); and J. W. Ritchie: *Human Physiology* (World Book Co., Yonkers, N. Y.). More advanced works, to which the reader may refer for special details, are J. P. Pavlow: *The Work of the Digestive Glands* (J. B. Lippincott and Co., Philadelphia), a classic; G. N. Stewart: *A Manual of Physiology* (William Wood and Co., N. Y.); M. H. Fischer: *Physiology of Alimentation* (John Wiley and Sons, N. Y.); T. B. Robertson: *Principles of Biochemistry* (Lea and Febiger, Philadelphia); O. Hammarsten: *A Text-Book of Physiological Chemistry* (John Wiley and Sons, N. Y.); W. H. Howell: *Physiology* (W. B. Saunders Co., Philadelphia); L. Luciani: *Human Physiology,* volume 2, (Macmillan Co., N. Y.); R. Burton-Opitz: *Text-Book of Physiology* (W. B. Saunders Co., Philadelphia); J. J. R. Macleod: *Physiology and Biochemistry in Modern Medicine*

(C. V. Mosby Co., St. Louis); W. M. Bayliss: *Principles of General Physiology* (Longmans, Green and Co., N. Y.); and E. H. Starling: *Human Physiology* (Lea and Febiger, Philadelphia).

APPENDIX

Average Weights for Men and Women, as Compiled by the Metropolitan Life Insurance Company.

Men. Height, Ft.	In.	Weight, Lbs.	Women. Height Ft.	In.	Weight, Lbs.
5	1	120	4	10	108
5	2	125	4	11	112
5	3	130	5	..	114
5	4	135	5	1	118
5	5	141	5	2	123
5	6	145	5	3	126
5	7	150	5	4	129
5	8	154	5	5	133
5	9	159	5	6	137
5	10	164	5	7	142
5	11	169	5	8	146
6	..	175	5	9	150
6	1	181	5	10	154
6	2	188	5	11	158

Normal Weight of Males at Various Ages.[1]

Height. Ft.	In.	Ages 15 to 24 years. Lbs.	25 to 29 years. Lbs.	30 to 34 years, Lbs.	35 to 39 years. Lbs.	40 to 44 years. Lbs.	45 to 49 years. Lbs.	50 to 54 years. Lbs.	55 to 59 years Lbs.
5	0	120	125	128	131	133	134	134	134
5	1	122	126	129	131	134	136	136	136
5	2	124	128	131	133	136	138	138	138
5	3	127	131	134	136	138	141	141	141
5	4	131	135	138	140	143	144	145	145
5	5	134	138	141	143	146	147	149	149
5	6	138	142	145	147	150	151	153	153
5	7	142	147	150	152	155	156	158	158
5	8	146	151	154	157	160	161	163	163
5	9	150	155	159	162	165	166	167	168
5	10	154	159	164	167	170	171	172	173
5	11	159	164	169	173	175	177	177	178
6	..	165	170	175	179	180	183	182	183
6	1	170	177	181	185	186	189	188	189
6	2	176	184	188	192	194	196	194	194
6	3	181	190	195	200	203	204	201	198

[1] Tibbles: Food in Health and Disease, p. 465.

INDEX